ESTABLISHED 1884

RAILWAY ENGINEERING
AND MAINTENANCE OF WAY

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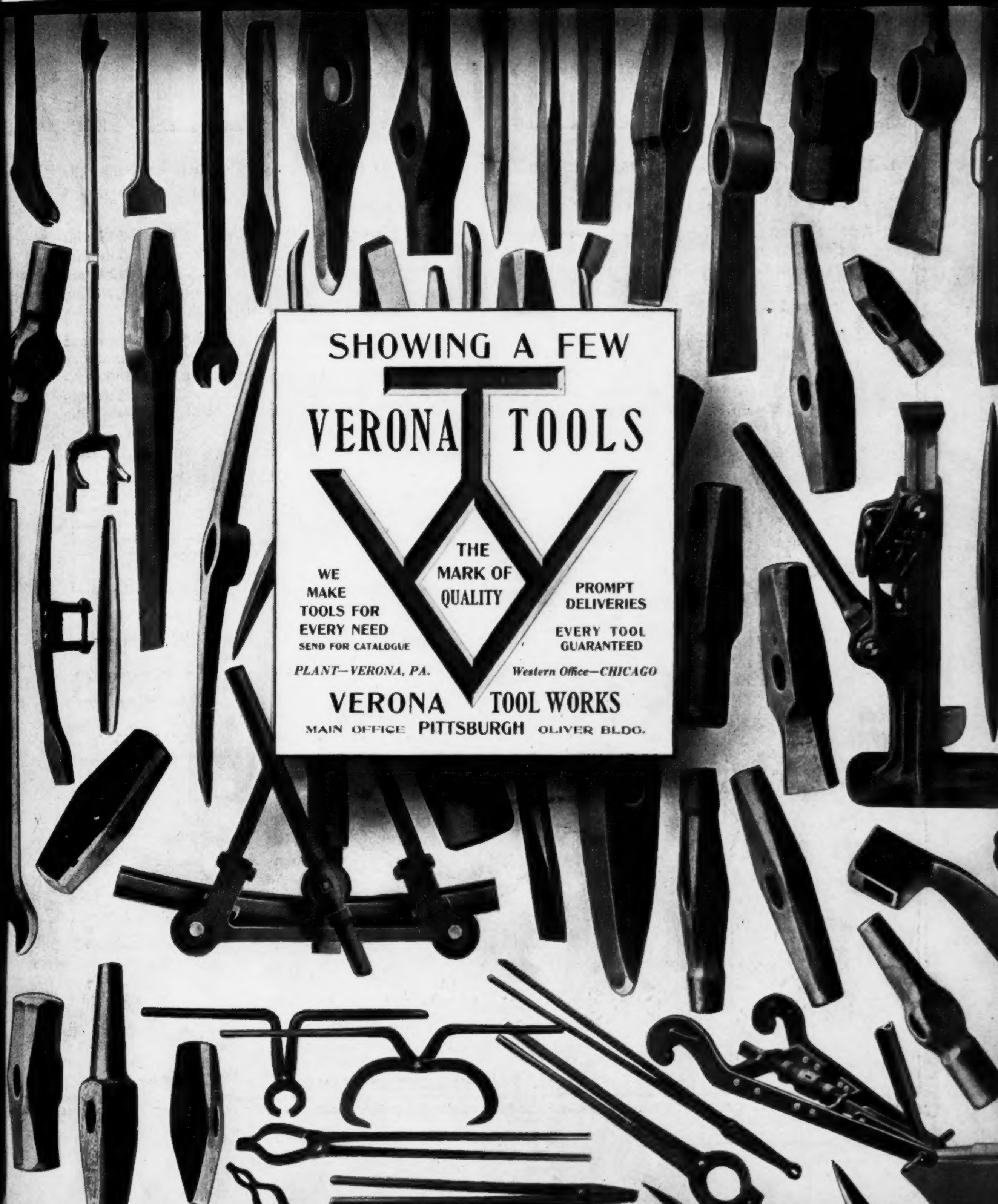
1916



Ramapo

MANGANESE TRACK WORK A SPECIALTY

AUTOMATIC SAFETY SWITCH STANDS

1. POSITIVE THROW.—Ramapo Safety Switch Stands are rigid for hand operation. The operator raises the handle, thereby releasing the spindle from the automatic mechanism, then throws the switch, but cannot lower the handle or relock switch unless the points are fully thrown.

2. AUTOMATIC SAFETY FEATURES.—A train or car can trail through a switch when set wrong, locked with a Ramapo Safety Switch Stand, without breaking the switch points or injuring the switch stand. The first pair of wheels forces the switch points open, compressing springs in the switch stand, and when points are half way thrown the springs snap the points the rest of the way. The stand is left locked in new position, just as if thrown by hand, and is again ready for either hand or automatic operation.

3. ADJUSTABLE FEATURES.—All Ramapo Safety Switch Stands are furnished with adjustable throw and adjustable moving-rods, unless otherwise ordered. Adjustable switch rods are not required, as either switch point can be adjusted. The throw can always be adjusted to suit that of any switch, one-half turn of the eye-bolt crank affecting the throw one-twelfth of an inch. See table of crank adjustments below. The distance of stand from switch can be readily adjusted with the adjustable moving-rod without moving the stand on the ties.

CRANK ADJUSTMENTS FOR RAMAPO SAFETY SWITCH STANDS

THROW OF STAND	"A"	THROW OF STAND	"A"
3½"	2 15/32"	4¼"	3"
3⅝"	2 9/16"	4⅜"	3 3/32"
3¾"	2 21/32"	4½"	3 3/16"
3⅞"	2¾"	4⅝"	3 9/32"
4"	2 27/32"	4¾"	3 11/32"
4⅛"	2 15/16"	4⅞"	3 7/16"
4¼"	3"	5"	3 15/32"

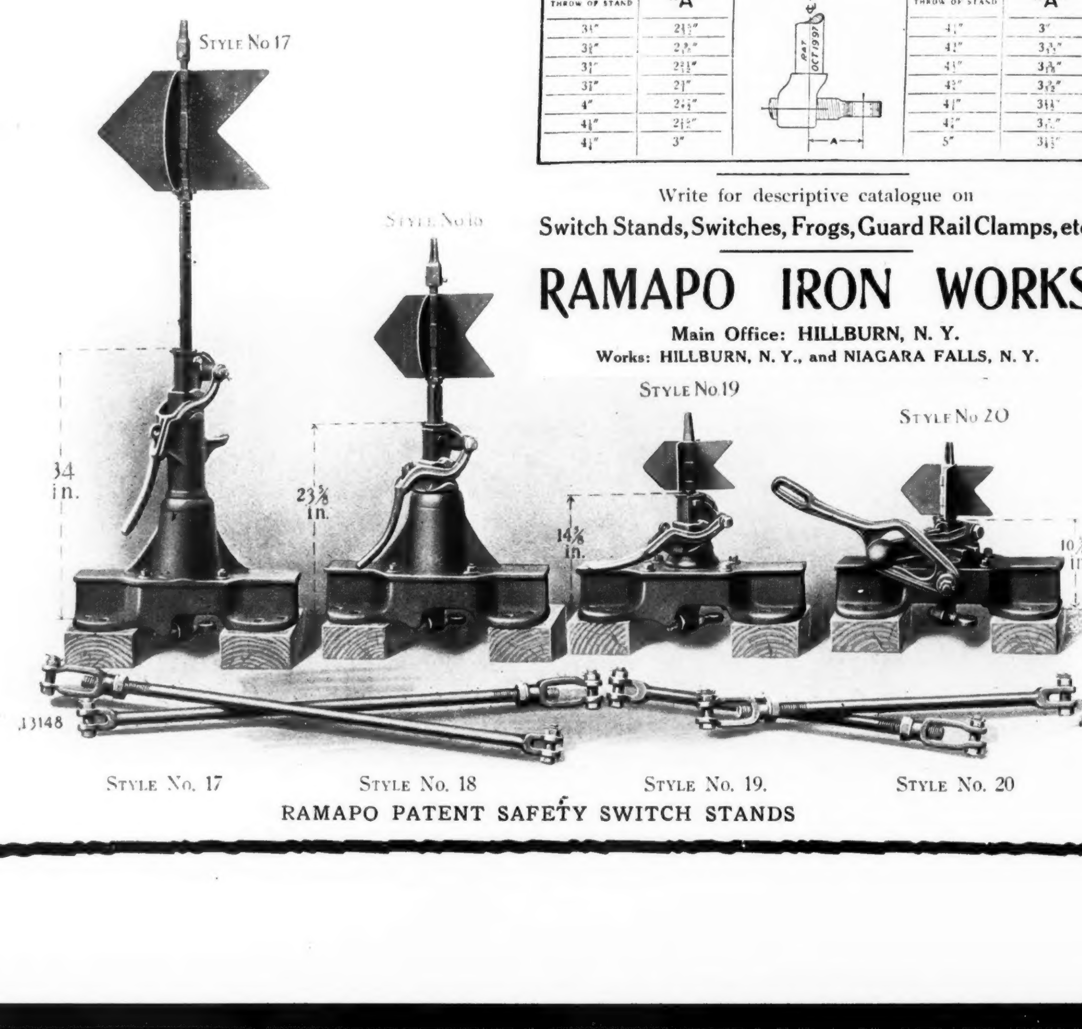
Write for descriptive catalogue on

Switch Stands, Switches, Frogs, Guard Rail Clamps, etc.

RAMAPO IRON WORKS

Main Office: HILLBURN, N. Y.

Works: HILLBURN, N. Y., and NIAGARA FALLS, N. Y.



Style No. 17 Style No. 18 Style No. 19. Style No. 20

RAMAPO PATENT SAFETY SWITCH STANDS

PUBLISHER'S TALK

There are Many Ways to Judge

of the effectiveness of advertising in a business journal like RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

One of these was forcefully illustrated in the case of a manufacturer one of whose several departments sold goods to railway companies. The advertisement of this manufacturer was published each issue for about four months, when it was ordered discontinued. A representative of the publisher called to inquire what the trouble was. The advertiser stated he regarded the advertising as an expense, because so far as he could see it had brought him no returns.

Just then this manufacturer received a telegram ordering a large number of his "Type C" apparatus. The manufacturer turned to the publisher's representative and said "What do you think of that? Here is a telegraphic order from a road with which we have done no business for years." The publisher's representative inquired if the manufacturer had had anyone visit that road of late and whether he had sent out any printed matter, or circular letters, and to each inquiry the manufacturer said "No. My attention has been concentrated on other departments."

The publisher's representative then suggested that it was very likely that the advertisement brought the order, as that advertisement illustrated and described the "Type C" apparatus.

And the Advertiser

thereupon saw a great light, for he said, "Do you know, that explains everything. During the past four months, while our advertisement has been appearing in your publication the business of that department which handles the "Type C" apparatus has quadrupled. Orders have come in from entirely new customers and from many with whom we haven't done business for years, without any specific indication as to what started these orders in our direction. The only thing we did during those four months that we did not do before, was to carry this advertisement in your paper."

The Moral Is:

Advertising in a journal like RAILWAY ENGINEERING AND MAINTENANCE OF WAY pays, and it can be proved that it pays, if the advertiser will only analyze the source of the orders and inquiries he receives in his daily mail. There are a number of other ways in which such advertising can be proved to be a profitable investment for the manufacturer. These will be covered in later "Talks" on this page.

RAILWAY ENGINEERING
AND MAINTENANCE OF WAY
WITH WHICH IS INCORPORATED ROADMASTER AND FOREMAN

New Series Vol. XII
Old Series Vol. XXXI *Established 1884* NEW YORK, FEBRUARY, 1916 *Copyright 1916* No. 2

CONTENTS

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Lessons Which Mean Something

We never know what we can do until we have been compelled to act. These past years of forced economy have taught railroad managers many things. The efficiency which has been exercised here, there and everywhere on the railroads has brought about marvellous results and decidedly beneficial ones, too. Things have been accomplished which, heretofore, were deemed nothing but dreams. When circumstances demanded real ingenuity in operating methods it was promptly forthcoming. Like the husband-man whose income is meagre; but who has a family to support and supports it, the railroad managers have employed all the methods of economy known to the science of railroading; have introduced successfully many new ideas and under the rigid tutelage of want have acquired habits which will serve them well for all time.

These nice lessons in the care of material; the running of trains and in other directions will be the means, later on of saving many a railroad, to the end that dividends may be assured and the interest on its bonds be promptly met. The past eight years full of so many struggles have without doubt been blessings—in disguise, perhaps—at the time, but, now, quite understood. There is no reason why the average railroad should not be handled exactly as any business usually is. As the science of railroading grows more exact we can readily perceive the trend of affairs. There is no business which involves so many details, as the railroad business, and there is no field which presents so many satisfactory results, as this business does, when true rules of care and economy are put in vogue, under rigid discipline, and followed. We have yet to find a man who has selected railroading as his profession who is not thoroughly interested in it, as he moves upward. This is one of the fundamentals which usually invites success not only for the man but also for the company which gives him employment.

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Scarcity of Track Labor

The track labor situation, as far as may be forecast from present conditions, bears every indication of a shortage, not alone for this spring but for some time to come.

The factories of the east are calling for common labor, the governments of Europe have recalled what men they could for soldiers, and the winter's supply of new labor from Europe has been very much less than usual. These considerations all suggest that the big cities will not furnish the usual amount of track labor when the call for the spring increase in maintainance forces is sounded.

Much of the labor has found not only more profitable employment, but all year round rather than seasonal or casual employment. The new labor, which does not appreciate that much track work in this country is temporary employment, have, on account of the embargo on emigration enforced by the belligerent countries of Europe, not put in their appearance.

Engineering officials who do not want to be seriously embarrassed by shortage of labor can profit by the example of one official in the middle west who now has a small force of men engaged on extra work, and is planning his inspection and distribution of material, clearing of drains, etc., to keep that gang at work for the rest of the winter. He has reached the conclusion that even with this small force on hand, with the experience they will gain between now and then, he will have an advantage when spring work starts. And further, that by beginning the spring work early and keeping at it, it will cost less to hold these men than it would to find new ones when the time comes and the better grades of labor for this work are scarce on a competing labor market.

This official's immediate problem does not differ from general conditions to such an extent that similar foresight to his would help to solve the general track labor problem.

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Fundamental Reasons for Derailments

The Interstate Commerce Commission has reported and shows comparative figures relating to train accidents covering the period from the year 1902 down to the close of June 30, 1915. In 1902 there were 8,675 train accidents reported to the Commission, 5,042 of which were caused by collisions and 3,633 were due to derailments. In 1908 collisions had materially decreased, but derailments had increased so that in number the causes practically matched each other. In 1915 the number of derailments had increased to 6,849, while collisions had decreased to only 3,538. The Commission having investigated the causes of derailment during 1915, in 40 different instances found that 11 of them were due to "bad track." Bad track, of course, is due to either lack of attention or faulty material, and perhaps to both. Exercise of extreme economy is more often the cause, and there have been occasions, unfortunately, to go to extremes more than often in the past several years. As a rule, when orders go out from

headquarters to reduce expenses the track department suffers; men are lopped off all along the line and supervisors and roadmasters are forced to meet the call as best they can. As the track is the fundamental basis of all the business this presumably economical move is more frequently in the direction of trouble than otherwise, and we have all seen what unfortunate results are likely to follow. One derailment on account of a badly maintained track may result in damage so large that all the supposed economy put in vogue on 200 or more miles of a system is wiped out in a moment with something left, perhaps to apply on the best part of another 200 miles. High speed, too, as occasion often seems to require, is another cause; but this can be more easily overcome. Let the track be good or bad, some managements are especially wise when they limit the speed of all trains and hold to it under all circumstances. Rails fail now and then. Heavy trains and more powerful locomotives and equipment are operated over some lines where the rails hardly warrant it and unless they are properly tied there is usually but one result in the end. If, however, the matter of derailments is run down to its most vital features it will be found that the reason lies largely in economy badly exercised in the first instance; unwarranted excessive speed in the second, and rail failures in the third. In every case it is largely a question of management, and if the railroads are setting out to fathom this interesting subject of derailments as they should they will save money by remembering that by being penny wise they will unexpectedly learn that they have been more than one pound foolish. When it comes to establishing rules of economy let the track alone in economy orders; keep it up to a top standard at all times, regardless of everything. A poor equipment will run on a good track, but neither good nor bad equipment can be handled successfully on a bad track.

Making the Convention Pay

When the doors of the Coliseum open, Monday morning, March 20, there will be gathered in Chicago a host of railroad and railroad supply men from all over the country. The railroad men have spent time in preparing papers and discussions for their association meetings, as well as in arranging their work so that they can be absent. The supply men have spent time and money, not only in preparing their exhibits, for their spaces, but in the research and experiments, and service tests that have developed the devices they exhibit, and by calling in their sales force to attend the convention, and explain details of the appliances there.

All this effort must be considered an investment, if it is to continue, year after year, and we must look to the results to determine its value. The results we look for are the spreading of information from railroad man to railroad man, from supply man to railroad man, and from railroad man to supply man. In every one of these cases the value of the information secured will depend to a great extent on the time and care spent in its preparation.

Before our readers come to the convention, they are urged to study the list of exhibitors at the convention, and make notes of the subjects that are of greatest interest to them. Then when they arrive at the Coliseum they can arrange a systematic plan for covering the exhibits in which they are interested, with the least possible lost motion or lost time.

It is worth while to avoid the busiest hours, as salesmen then are likely to have their attention diverted to such an extent that much time is lost. It is worth while to make a preliminary survey of the booth, from the aisle, and determine as far as possible the most interesting features of the exhibit, before taking them up in detail one by one. It is worth while to have a note book very handy, and it is no reflection on any man that he is unable to remember and assimilate the vast amount of information offered him during the convention, unless he will transfer the burden of figures and details from his memory to his notebook. It is worth while to waste as little time as possible in getting over the features of a device to the limit of your present knowledge—to where you can begin to gather facts that will extend your information; it wastes both your time and a salesman's time for you to listen to facts with which you are already familiar. It is worth while to get what descriptive matter you can, and to wait until you are back from the convention to read it over, with your notes on that subject, to get the best possible grasp of the subject. It is worth while to make a note or get a card of the man you talk with, for any questions that may come up later can be profitably referred to him, with the knowledge that he can tell how far the subject is clear to you.

There are two extreme courses to be avoided, in studying the exhibits; first, to treat each exhibit as equally important to the next, and so devote no more time to the subjects in your own special field that you do to subjects of little except general interest to you. The second is to confine all of your attention to your own field, and not take advantage of the exceptional facilities offered to familiarize yourself in a general way with the advances made in related fields of work.

Between these two lies the proper course, and every man will have to hold himself responsible for the most advantageous distribution of his time. It is not out of place to suggest that when the booths you are most interested in are crowded, you cannot fare worse in booths of less specific interest to you, for all the information wanted from them can often be secured from the aisle, whether the booth is crowded or not. Mornings are the best time for the concentrated work in your own department, as every exhibit will be set in order, and more freedom is possible in comparing devices than later, when the attendance increases.

The subject of how best to make the convention serve you and through you, your work and your railroad is worth painstaking study. All the thinking and planning that can be done beforehand will result not only in more time available for the purposes of the convention, but in a more advantageous use of that time.

Grade Separation at Crossings

The movement to eliminate grade crossings in main line track is gathering momentum with each passing year to such an extent that some roads are now making a practice of avoiding such crossings on all new construction.

In the engineering departments of railroads whose experience in grade separation has extended over a number of years, there has become available a considerable amount of data from which it is possible to determine the most advantageous method of separation to recommend for the solution of any specific problem which is referred to the departments.

The article on grade separation appearing elsewhere in this issue was prepared with this idea in mind: to furnish in compact form, for reference, a comparison of the various methods of grade separation and of the conditions for which each is best adapted. The comparisons are made from the standpoints of engineering practice and initial and operating or maintenance costs.

Such roads as have not had these conditions to meet will find the material authoritative. No attempt is made to prescribe a definite design for any individual conditions, nor to present cost estimates except for purposes of comparison. However, a tentative estimate on a given project could be facilitated and checked to a certain extent by reference to the data given for general cases.

Watching the Rail at Work

The explanation of the compression of the rail under the wheel load, as outlined some years ago by Prof. Johnson, still holds good. In this explanation, the minute "flow" of metal under pressure is taken for granted, or at least accepted as a fact. Metal compressed very heavily on a small area, as a wheel standing on a rail, is productive of a definite effect. The metal at and below the point of contact sinks down as a result of the pressure, and its displacement brings about a lateral "flow" of the metal below, which seeks relief by the upward movement of the metal surrounding the point of contact.

It must be remembered that Prof. Johnson's analysis of the "flow" of metal under these conditions is envisaged only by the eye of science. In the language of ordinary thought it represents little more than a tendency. Yet as there is no effect without a cause, so it is manifestly impossible to escape the conclusion that the pressure of a wheel on a rail produces a "flow" of metal, however slight it may actually be.

Viewed with the eye of science, a driving wheel standing on a rail is really in the centre of a shallow depression. The area of contact is dependent upon the load carried. Some experiments made by the U. S. Ordnance Department on this subject showed that a wheel loaded to 15,000 lbs. stood on an area of approximately 0.2 of a square inch, and that when this wheel sustained a weight of 60,000 lbs., the area became nearly 0.7 of a square inch. From this it seems fair to suppose that the resulting hollow-and-hill condition of the rail was more marked in the latter than in the former case.

A locomotive standing on a pair of rails rests in a number of minute depressions, with a raised ring around each; the number of depressions corresponding to the number of its wheels, and the depth proportional to the load on each. This would present an aspect very like what might be seen through a microscope, where the surface film of water would be slightly depressed under each foot of a water-spider. The movement of a locomotive along such track would be to make it constantly run uphill and draw behind it cars doing the same thing. The rise and depression of the rail in front of and under the locomotive would always be there, and would be somewhat similar to the catenary wave, which on a suspension bridge precedes the load.

The total energy expended in thus surmounting the minute hills in front of an engine and cars is not great for any one train. Its power-consuming quality only becomes apparent when considered in the aggregate, where all trains and a series of years is considered. The individual effects of load, whatever they may amount to, are augmented at two points in the revolution of the driving wheels where they reach a maximum. These are when the pull down and the push up of the connecting rod throws a greater weight on the rail than that due to the static load. This effect is partly, though not wholly, done away with by the action of the counterbalances.

The heavy stiff rail is, other things being equal, not only an engineering requisite, but it operates to the advantage of the mechanical department as well by eliminating destructive shocks to rolling stock. The more flexible the smaller rail, as expressed in the langauge of the prize ring, it receives severer punishment, which causes more or less rapid deterioration of the road-bed, and it adversely affects the rail itself. It constantly uses up power which could be more profitably employed in pulling the paying load.

The whole subject opens up a wide field of systematic and scientific investigation. We have not now at our disposal all the data which can and will be brought to light, in the future. Our researches along the lines of chemical composition, heat treatment, rail rolling, and rail form, have progressed far enough to teach us some very valuable lessons, but more remains to be done. The other line of investigation, that of "watching the rail at work," is still in the earlier stages of its existence, and there is likelihood that it will be proceeded with further than it has been so far. There is no doubt that a most instructive and useful mass of facts await the explorers who carry on the line of work already begun by Prof. Johnson, Dr. Dudley, the U. S. Government, the C., B. & Q., and others, who have directed attention to how the rail carries its load, the "why" of its section, its supports and its relation to moving locomotives and cars, and in fact to its position not only in the laboratory, but out in the open, in railroad use, as a contributing factor in the science of transportation.

Martins Creek Viaduct, Delaware, Lackawanna & Western

Three-Track Reinforced Concrete Structure; Arches Built in Two Ribs Pierced with Openings for Inspection; Refuge Balconies for Men and Handcars

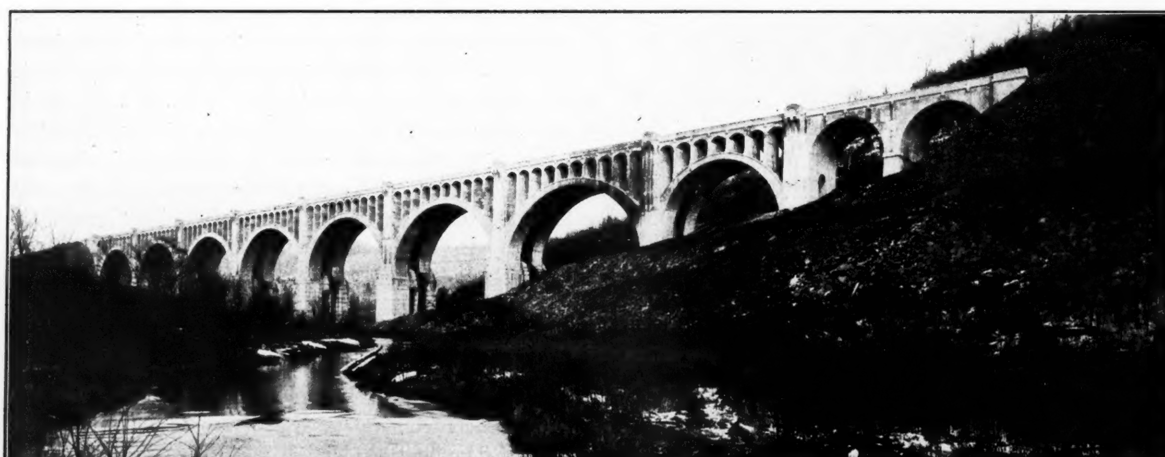
In our issue of November, 1915, we described and illustrated the great Tunkhannock Creek Viaduct recently completed by the Delaware, Lackawanna & Western Railroad on the new forty-mile re-location of the main line between Clark Summit, Pa., seven miles west of Scranton, Pa., and Hallstead, Pa., fourteen miles east of Binghamton, N. Y. This viaduct is the largest concrete railroad viaduct of its kind in the world. It is an interesting fact that the second largest concrete structure of this type, the Martins Creek Viaduct, although somewhat dwarfed by the gigantic proportions of the Tunkhannock Creek Viaduct, was built on this same change of alignment.

The Martins Creek Viaduct is a three-track structure 47 ft. wide, 1,611 ft. long and 150 ft. above the creek. The piers are carried to rock, 25 ft. below the bed of stream, giving the structure a maximum height of 175 ft. It consists of seven 150-ft., three-centered, arches with a rise of 59 ft.; two 100-ft. full-centered, arches, one of which is an abutment arch and cannot be seen in our illustration, since it is buried in the approach fill on the left or west end. There are two 50-ft. full-centered, arches on the west end that give the necessary length, which prevents the approach fill encroaching on the tracks of the old line that pass under the fourth arch from that end.

arch, but does not reach the back of the last main arch. The pressure exerted by this high embankment on the pier assists materially in reducing the eccentricity of the resultant thrust of the 150-ft. and the 100-ft. arch spans. The entire floor is waterproofed with three plies of Minwax saturated cloth, laid in Minwax hard waterproofing and protected by a 1½-in. layer of asphalt mastic furnished by the Johns-Manville Co. The tracks are laid on stone ballast 3 ft. deep, and are enclosed between massive parapet walls, 3 ft. thick and 3 ft. 6 ins. high above the top of the rail. The walls are substantially reinforced, insuring a large factor of safety in the event of a derailment.

The architectural treatment is commendable. The main arch with its graceful curve, approximating to an eclipse has been set at such a height as to give the proper balance between the sub-structure and the super-structure. Grace and utility have been combined in the design of the overhanging pilasters. This feature of the architectural treatment is built in the form of a balcony, or refuge niche, into which the trackmen working on the bridge can place a handcar to clear passing trains.

The contractor, anxious for the best results, cooperated with the engineering department of the railroad in an endeavor to obtain the best possible finish



Martins Creek Concrete Viaduct on the Delaware, Lackawanna & Western Railway

The main arches are built in two ribs, each 17 ft. 6 ins. wide and 12 ft. apart. The depth of the arch ring is 6 ft. at the crown and 12 ft. at the haunch. They are surmounted by solid transverse spandrel walls 12 ft. 6 ins. apart that support the floor arches and the parapet walls. The floor has a depth of 2 ft. at the crown, and is reinforced with 1-in. square bars placed 7 ins., centre to centre. The top of the floor is ramped 3 ins. from the crown of each arch to the spandrel walls through which the drainage is carried in 6-in. cast iron pipes to the opening between the main arch ribs. A floor system similar to that over the main arches is continued to the crown of the 100-ft. abutment arch. The heavy approach fill slopes through the hollow superstructure and completely buries the two ribs of this

of the concrete without resorting to surface treatment. This was accomplished by the construction of heavy timber-formed units, lined with stout galvanized iron plates, and by giving careful attention to the spading of the concrete against the forms, to keep the aggregate away from the surface. The lining of the forms proved to be economical as well, since the metal preserved the timber and permitted the repeated use of the units.

The piers are 20 ft. wide at the springing line, and 10 ft. below the springing line they are increased to 28 ft. in order to form a ledge 4 ft. wide on either side of the pier. On this the structural steel centers for the main arch rings was supported. This ledge is concealed by an ornamental belt of steps, built after the removal of the center. The 12-ft. opening between the

arch ribs facilitated the moving of the center. The piers of the main arches are solid for 17 ft. below the springing line and below that elevation they are divided into two legs 23 by 28 ft., separated by a 12-ft. opening. Strips of moulding were placed at 5-ft. intervals on inner faces of the pier forms to make the construction joints and the horizontal scorings around the pier. In this manner the unsightly construction joints so often in evidence in this kind of work, are hidden by the scoring.

The excavation for the foundation varied from 10 to 60 ft. below the surface of the ground. This was made in open caissons, built of Lackawanna steel sheet piling. The viaduct contains 78,000 cu. yds. of concrete and 1,000,000 lbs. of reinforcing steel.

A series of openings in the walls of the piers just above the lower arches, enables the top side of these arches to be inspected as well as the pier walls and underside of the upper arches. A man may climb up to the top of the lower arches on a ladder at one of the abutments and make a tour of the entire structure without being compelled to leave it. The discolored portion of the viaduct, as seen in our illustration, was caused by the drippings from the contractor's outfit, but will later on be entirely cleaned off. The viaduct is an artistic piece of work and serves to enhance the beauty of the rolling landscape at this point on Martins Creek.

Mr. G. J. Ray, chief engineer of the D. L. & W., had direct supervision of the design and the construction of the viaduct. Mr. A. B. Cohen, concrete engineer of the road, had charge of the design. The construction was supervised by Mr. F. L. Wheaton, and Mr. W. L. Lozier, resident engineer, was in charge of the work.

The contract was awarded in June, 1912, to F. M. Talbot Company of New York City, of which Mr. F. M. Talbot is president and Mr. E. J. Mailady is secretary and treasurer. The viaduct was completed six months and 15 days ahead of the contract time.

Programme of Section Work for Gangs

By W. KIRCHBAUM

This outline is intended mainly for roads using gravel, cinder or slag ballast, as stone ballast may be handled in a different manner during wet weather.

Early spring track work should be commenced before the frost is out of the ground. The entire section should be gone over, paying close attention to spreading places in the track and where this is caused by the rail being canted, the ties should be properly adzed and rails spiked in proper positions. Bolts should be inspected carefully and loose ones tightened. All scrap that has been snowed under during the winter should be gathered and placed in scrap bin at the car house.

Any accumulation that has lodged in sewers and waterways should be cleaned out so as to allow the early spring rainfalls to run off without doing any damage.

If any joints are observed that are churning and which cannot yet be tamped they should be shimmed to prevent the rail from breaking. I do not believe in doing much tamping at this season of the year before the frost is entirely out of the road bed, as otherwise there may be some very high places left in the track when the frost goes out. Ballast that is worked when wet will soon get worn out and will not handle nicely when summer comes.

At this season of the year the section gang is usually composed of a foreman and 2 or 3 men and it is surprising what such a gang can do in the way of little jobs when proper system is followed. It is very important that minor repairs to track tools be made at this season of the year. This can be done on rainy days when the weather is too bad to work outside. The car house can be converted into a shop and all grinding of adzes, axes, etc., done, spike maules should be rehung and in fact any work done that will put the summer tools in first class condition.

After the frost gets out of the ground and roadbed, track should be worked from end to end of the section, taking out all the shims that have been put in during the winter months, tamping up any places that require it and always keeping a good line. While making the first trip over the section and doing all this work the bolts should again be inspected and tightened where necessary, for a loose joint gets low very quickly. The next thing to look after is the right of way fences which should be put in order so that they will require no more attention during the summer. It will be easy at this time to see just which fields the farmers are going to use for pasturing and which fences must be put in the best shape to prevent stock getting on to the right of way.

Digging holes for fence posts is the most easily done in the spring when the ground is soft and in addition there is no high grass to contend with. And when a stretch of woven wire fence is properly put up at this season it will hold a more even expansion during the entire year, as you are putting it in during the period of medium temperature. Five or six men can in a few days go over an entire section and put the fences in shape to carry them over until the following spring. By the time the fences are fixed it will be time to start tie renewal. These should be made as quickly as possible consistent with good work the ties having been unloaded and placed in piles convenient to the places they are to be put in during the fall and winter. Under heavy traffic it is well to keep the new ties tamped and spiked as fast as they are placed, thus eliminating any danger of broken rails or track spreading. It seems best to have each pair of men do the entire work on the ties, pulling them out and putting in the new ones and tamping them. This keeps the track safe for trains much better than if the gang is split up, part of them digging out, others pulling out, others putting in ties and still others tamping them. The foreman should help out wherever needed.

After the tieing has been completed and the old ties piled and burned and the right of way given a general cleaning up, a few days should be spent in cleaning up the ballast from weeds and grass. The best article for this work is a scuffer, made from a piece of an old crosscut saw 12-in. long. The teeth are cut off and two holes punched in the center to which a small iron rod is attached as a rake handle is moulded. The back of the saw should be used for cutting edge. This can be filed from time to time and this tool allows a man to stand in a working position which allows him to do much work without tiring him, and with this tool one laborer can cut as much grass as three laborers can with ordinary shovels. A man should be provided with a common garden rake to rake off the grass and weeds that have been cut so as to leave the grass line and gravel line in a very neat condition. The scuffers provided already made up I have found to be too light and not as serviceable as the home made one.

After the ties are in and the weeding done the track should be put in good surface and line and given a very neat appearance. This should be done completely by starting at one end of the section and working toward the other. Section gangs usually do not do heavy sur-

facing, the extra gangs being put on to do this work, but these do not do as permanent work as the section gang. The laborers do not care for results but simply work to get in their time. The result is that track ballasted by such a gang will ride all right for six months or a year and then will get badly out of surface because it becomes center bound. A section gang of 6 to 8 men should be employed to do the heavy surfacing instead of letting the extra gangs do it. Then the work can be started at one end of the section and giving a lift of one or two inches as you have ballast and in the meantime if a raise of one inch is given, the inside or the center of the tie should be tamped only a shovel length from the rail on each end. If two inches raise is given the center should be tamped about two shovel lengths from the rail. The part of the tie underneath the rail should be well tamped with a bar or tamping pick. The raising should be started in the morning, the men tamping only the ends of the ties with the exception of the joints where the insides should be tamped, and this work can be pushed along that way until dinner time. Then the gang can drop back and tamp the centers and line and trim up the track raised in the morning. The bolts should then be tightened and after the men have become accustomed to this system it is surprising how much ground can be covered each day. After the general surfacing of the whole section is completed the gang can run over the track quickly and pick up the few little spots which have developed. Broken ties should at the same time be replaced with new ones, the ballast line polished up and all public and private crossings put in a good condition and then grass and weeds should be cut and burned from the right of way.

After the above work has been done on the main line the side tracks should be given some attention. They may need some new ties and perhaps some of them will need complete surfacing. This should all be done before the fall rains and bad weather sets in. The foreman after doing this work should look after the waterways and sewers and get them properly cleaned out for fall rains and winter snows. At this time the forces will probably be reduced to a winter basis and unless full preparation has been made the foreman will have a hard time during the winter. The gang will probably consist of only two or three men and special attention should be given to switches, frogs and crossings, cleaning out from under the moving rails so that they may be easily cleaned of snow in the winter time.

During the winter a very careful and painstaking inspection must be kept up on the track. Switches, frogs and guard rails should be examined frequently, and also ice removed from them so that they will work easily. Plates on which points move should be oiled at least once a week and a few drops of oil should be put on the pipe that works the derails.

Rail rests should be made during this time if they will be required anywhere on the section and the ones which are on the section should be inspected and put in good shape, being sure that good rails are placed on them in every case.

Fence material should be arranged for and other little jobs that will shorten the summer work should be done. A great deal of shimming is sometimes necessary and care should be exercised to leave the track spiked solidly where this is done, especially where the shimming is so high that an ordinary spike will not hold the track to gauge. In this case rail braces of some sort should be used. The foreman should carefully watch the different parts of this section at this season of the year to determine the quality of his ballast and spot the places where it is puddling or churning. Where the places are found, the ballast should be dug out enough so that the water can be drawn away from the track. The churning joint not only allows the splices to become bent but is likely to cause a spoiled rail.

Conclusions from Rail Failure Statistics

Compilation of Sources of Rail Failures from Railroad Statistics

A report on the subject of rail failures compiled for the year ending October, 1914, was presented to the American Railway Engineering Association by Mr. M. H. Wickhorst, engineer of tests, rail committee, a brief resume of which is here presented. The statistics were furnished by the railroads which are members of this association. The failures were divided into, head, web, base and "broken."

The tonnage of rails given in the data sent in by the various roads shows kind of steel, year rolled, and the total tonnage in each year:

1909	421,210	514,302	935,512
1910	559,708	842,895	1,402,603
1911	233,270	630,694	863,954
1912	95,666	997,078	1,092,744
1913	72,496	1,202,060	1,274,556
1914	20,779	672,564	693,343

Lots less than 1,000 tons in any one year were not placed in the tables. The method of compiling the statistics was to make prints of the reports sent in by the railroads, then cutting them up along horizontal lines. These strips showed the units in the tables, and after sorting in suitable order and collecting into the desired groups, the information was made up into tables, from which cuts were made. The tabulation this year is limited to a classification by mills. For the same reason the committee continued to use failures per 10,000 tons as the unit of comparison.

The detail tabulations by mills and years rolled and a condensed table showing the failures of each year's rolling mill has been compiled. It is interesting to note the comparative performance of Bessemer and Open-Hearth rails for the several years' rollings. Figuring the failures per 10,000 tons of Open-Hearth rails as 100 for each of the years 1909, 1910, 1911 and 1912, the relative number of failures of Bessemer rails, together with the failures per 10,000 tons, is shown below:

1909	5	141.7	268.7	100	190
1910	4	76.3	158.5	100	208
1911	3	58.5	113.4	100	193
1912	2	20.1	44.4	100	221

The rails for 1913 and 1914 are not included in this comparison, as they are probably too young for reliable comparison. It will be noted that the failures per 10,000 tons of Bessemer rails were about twice those of Open-Hearth rails.

The records are closed for the 1908 and 1909 rollings. The 1909 rails showed as a general average for all mills, a lower rate of failures than the 1908 rails, and it is gratifying to note that the later rollings also show a tendency toward continued improvement as a general average.

A comparison with last year's statistics indicates, as a general average of all the mills, a gradual decrease in the rate of rail failures of rollings for the successive years since 1908, the year with which the records began. As a general average, the failures per 10,000 tons of Bessimer rails were about twice as much as those of Open-Hearth rails.

Railways of the Republic of Colombia, South America

By JOSE M. ROSALES, Commissioner of Colombia to the United States

Description of Railroad Situation in Colombia Dealing with Topography of the Country and the Location of Existing Roads

The Republic of Colombia lies in the northwest corner, as it were, of South America and has the Caribmean Sea on the north, Venezuela and Brazil on the east, Ecuador, Peru and Brazil on the south, and the Pacific Ocean on the west.

The area of the Republic is 505,000 square miles, and there is a coast line of about 2,000 miles on both oceans. From north to south it is longer than from St. Paul to New Orleans, and from east to west, in places, it is wider than from New York City to Chicago. Its area is equal to that of the New England States, New York, New Jersey, Rhode Island, Ohio, Indiana, Vermont, West Virginia, Delaware, Maryland, Kentucky, Tennessee and North Carolina. It is larger than France, Germany, Belgium and Holland combined, but a large part of the territory is still uninhabited. The population today is just 6,000,000. Colombia is consequently the third South American State in area and population, Brazil and Argentina ranking first and second respectively.

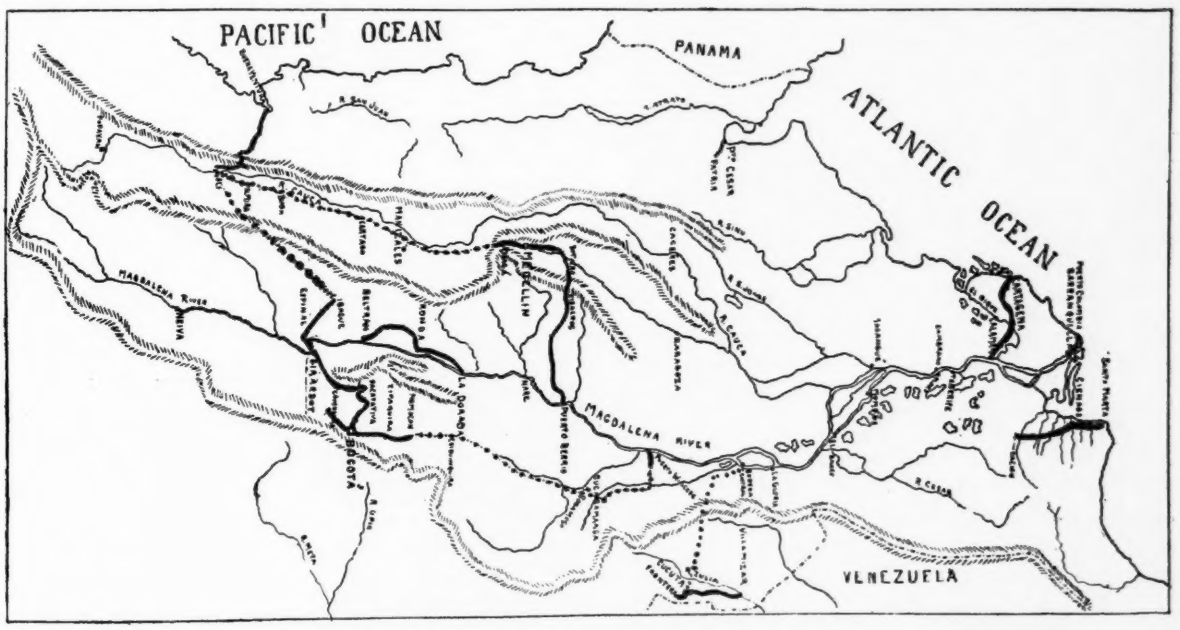
Topographically, the Colombian territory may be treated under two great divisions: a mountainous one on the west and a level district on the east; the former, with its elevated ranges and intermediate deep valleys, constitutes the Andean region. The immense eastern dominions, almost uninhabited and watered by such fine navigable rivers as the Arauco, Meta, Caqueta, Guaviare and Putumayo, consist of great plains on the north and dense forests on the south.

The great chain of the Andes on entering Colombia divides into three ranges that run in a northerly direction and end upon the shores of the Caribbean Sea. On the Central range, the most imposing of the three, the highest peaks of the Andes north of the Equator may be found: Huila, 18,000 feet; Ruiz, 17,000 feet; Tolima, 20,000 feet, and Hervea, 18,000 feet. All of these have, of course, icy tops, as the snow limit in the tropics is 13,000 feet. Tolima is covered with nearly 6,000 feet of snow from the summit down.

The relief map plainly shows the topography of this wonderful country and explains why the building and operation of railroads therein are confronted with difficulties in the extreme. To complete the connection of Bogota, the capital, with the Pacific Coast—now under way—it is necessary to cross the three mighty ranges already alluded to, which is a great engineering feat. As to the construction of railways along side the Andean valleys of the Atrato and Magdalena Rivers, especially in their lower course, is more than a serious task on account of the marshes and extensive lagoons of the lowlands, where the tropical vegetation is most luxuriant.

The mining interests of the country as well as the agricultural resources and the other industries require better railroad facilities. In fact, it is what Colombia needs in order to be able to assume its place among the progressive nations of Latin America. We have an annual output of gold to the extent of 40,000 lbs.; of platinum we export 2,000 lbs. annually; we have iron, petroleum and coal in abundance and the copper mines of Sierra Nevada, when properly worked will yield more mineral than those of Chile.

The last year we exported 120,000,000 pounds of coffee. Colombia is the second coffee exporter after Brazil, but I must say that ours is the better of the two, as we have plenty of humidity and shade in the Cordilleras, more than in any other South American country. The exportation of bananas amounts to 350,000 bunches monthly.

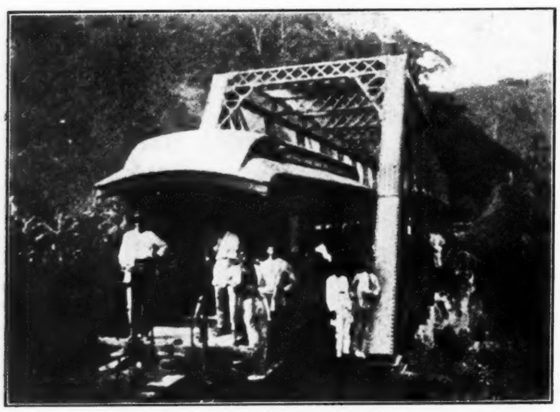


The Magdalena River District in the Republic of Colombia

Tunnel on the Girardot Railroad

As the industrial resources of the republic have grown, and now that the political affairs have become settled and conditions generally are normal, railroad activities are shaping toward the building of a complete national system, to which will belong all the different sections of railroad lines now scattered here and there throughout the republic.

To-day there are 14 different lines constructed and in full operation with extensions and connections pro-



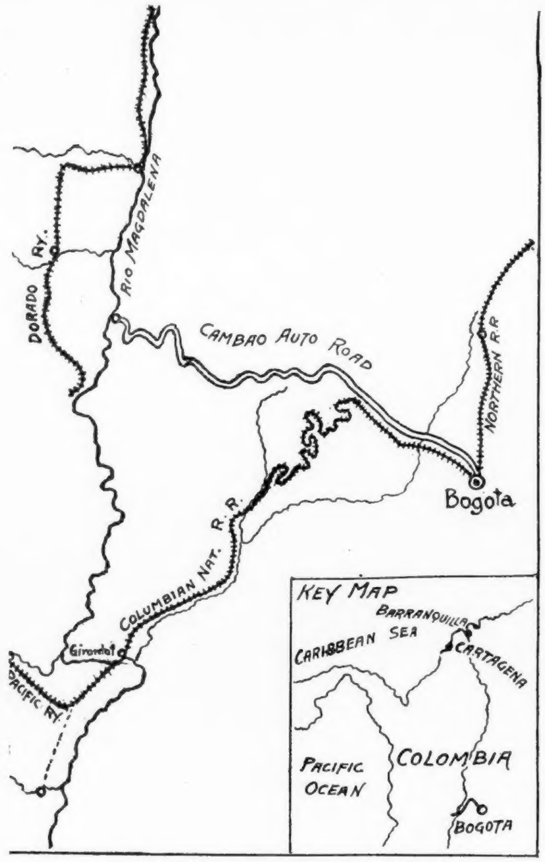
Railroad Bridge on the Antioquia

jected which will eventually bring about the national railroad system intended. Bogota, a flourishing city of 150,000 inhabitants, is the great centre from which everything in the republic radiates. The city was built by the Spaniards in 1538 and still keeps that dignified character and peculiar charm of the old Spanish capitals. It lies 8,600 feet above sea level upon a wide

Scene on the Girardot Railroad

plateau of the eastern range, while the Magdalena River is the great artery of traffic, occupying the valley between this range and the central one and flows north to the Caribbean Sea. This river, one of the largest in South America, is navigable for about 480 miles, from Baranquilla at the mouth of the river to Neiva, although the navigation is stopped just once by the Honda rapids.

The railway lines now in operation logically lead to this great river and naturally depend upon it to reach the northern coast. The general plan of the Colombian



Sketch Map of Colombian Railroad

Government to-day is to establish by a union of the present lines three complete systems of railroads to give impulse to all agricultural and mining resources of the country and to establish positive unity in all its commercial activities. The most important of these systems is the railway from Bogota to the Pacific coast. Upon this, as well as the improvement of the sanitary conditions of Buenaventura and our Pacific ports, all the energies of the government and the financial resources of the country are bent.

To reach the lower Magdalena River it is necessary to complete the line from Bogota north as indicated on the accompanying map, which shows the Magdalena River district, and to reach the same district farther north the line from Cucuta must be extended forward. From Bogota towards the Pacific coast the line has already been constructed to Girardot on the Magdalena, at a point 1,000 feet above the sea level, and on from there almost to the foothills of the Central Cordillera, while from the Pacific at Buenaventura eastward the line has already surmounted the western range of mountains and is at present crossing the Cauca River valley to meet the Bogota line. It can readily be imagined what

engineering problems are presented in this great work and what enormous expense is involved. To cross the central range the line must go over a pass 9,000 ft. high, while on both sides of the pass rise the snowy peaks mentioned before. But it is a glorious task which will eventually be crowned with success.

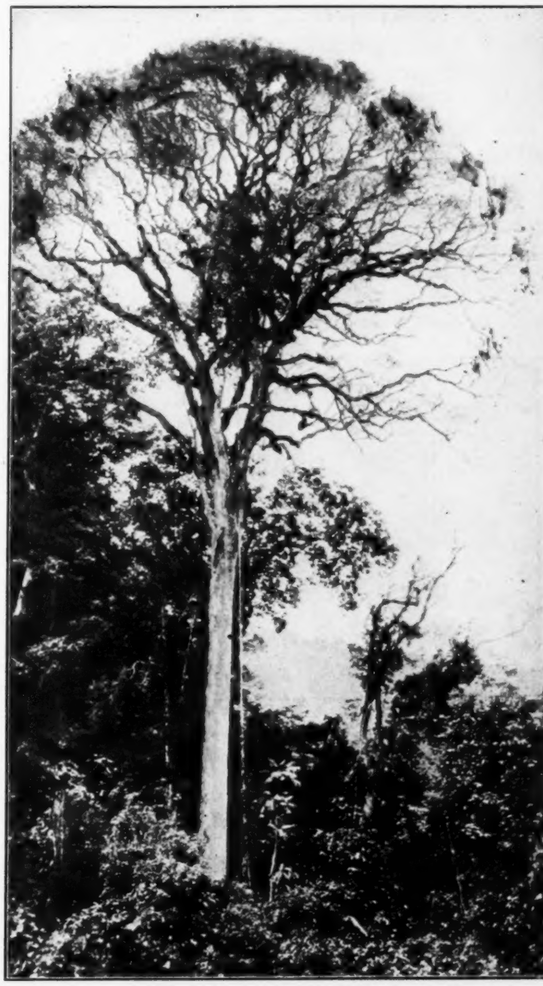
The Cucuta line is also a very important one, since all the coffee and other native products of the soil are grown in that district, and when the line is completed to the Magdalena the entire output of crops will seek the river and thence north to Barranquilla, the most consequential port on the Caribbean Sea. This route, too, for all merchandise imported, will save the custom duties now paid to Venezuela, making possible increased importations at great saving to the consumers.

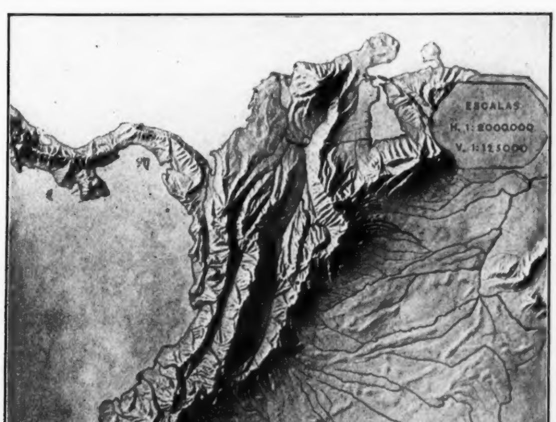
On account of the heavy grades encountered the standard gauge generally adopted is that of 3 ft. It is true that the railways of the Bogota plateau have a 3-ft. 6-in. gauge, but as the Girardot line, as well as La Dorada has 3 ft. and the same gauge has been decided for the Cauca and Antioquia lines, this gauge will meet all the requirements and become the standard all through the country.

The fourteen different lines heretofore mentioned and which will be finally put together to make the three systems projected are:

The R. R. of Antioquia, 102 miles
The R. R. of Barranquilla, 18 miles.
The R. R. of Cartagena, 65 miles.
The R. R. of Cucuta, 45 miles.
The R. R. of Pacifico, 105 miles.
The R. R. of Girardot, 82 miles.
The R. R. of La Dorado, 73 miles.
The R. R. of La Sabana (Bogota), 25 miles.
The R. R. of del Norte (Bogota), 40 miles.
The R. R. of del Sur (Bogota), 25 miles.
The R. R. of Santamarta (Bogota), 92 miles.
The R. R. Puerto Wilches, 12 miles.
The R. R. of Tolima, 30 miles.
The R. R. of Amaga, 30 miles.

The total mileage amounts to 740 miles, but with the chain complete there will be in the republic about 1,450 miles of railroad which will serve the country thoroughly and be the means of exploiting the natural wealth of the soil and developing the industrial activities of the people. In view of the attention now being directed toward the South American countries, here is a field well worthy of consideration on the part of capitalists, engineers and those engaged in the manufacture and sale of supplies.


Tropical Forest in Colombia



Relief Map of Colombia

Chesapeake & Ohio Railroad

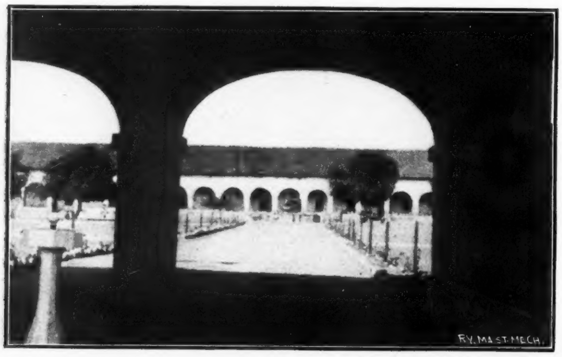
The Chesapeake & Ohio seems to be developing into a remarkable property. In the month of November last its net earnings were $600,886.19 as against $21,876.08 for the corresponding month in 1914; an increase of $579,010.11. From July 1 last—the beginning of the fiscal year—down to and including the month of November the net earnings show an increase of 155 per cent over the five months from July 1 to November 30, 1914. The gross earnings of the system for the first five months of the present fiscal year were $19,632,688.50, compared with $16,583,243.91 in the same period of 1914, an increase of 18 per cent, or $3,129,718.96. This shows that a vast volume of new business was developed and that conditions generally throughout the territory which this well-maintained property serves have improved to a wonderful extent. The Chesapeake & Ohio is well on its way toward more than remarkable success. It is an excellent example of highly efficient railroading.

A Novel Railway Waiting Station

By ALBERT MARPLE

Artistic Suburban Station Shelters, Constructed of Concrete, with Tile Roofs

One of the most attractive of the smaller railroad waiting stations to make its appearance in Southern California is a structure, built on a combination of Mission Spanish lines, shown in the accompanying illustrations. This attractive little station is directly opposite a boulevard from the old Spanish mission at San Fernando, known as the San Fernando Mission. This is one of the very old structures that are still standing and which was used by Spanish padres years



View Looking Out from Waiting Station

ago when the territory, now California, was still in the possession of Spain.

This modern open air waiting room is, with the exception of the red (Spanish) tile roof, made entirely of concrete, the walls and seats being solid. It is 16 x 28 ft. in size. In both the front and the rear there are two arches, each 9 ft. in width, through which an excellent view of the mission may be obtained from the interior of the room. The walls are 12 ins. thick, and the building has, both inside and out, been given a finish of rough sand. A pleasing feature is the arched windows above the seats at either side. On each side there are three of these windows, each window being

Exterior View of Waiting Station

3 ft. in width at the bottom. The roof, all round the building, has an overhang of about 4 ft. and is equipped with water gutters. The red tile roof contrasts nicely with the white plaster finish of the cement, and at each of the four ridges of the roof there is a little dome, out of which rises a short flag pole.

Along each of the two closed sides of this room there is a comfortable rest bench. The seat section of the bench is 18 ins. in width, 2 ft. in height, while the back section, which is raised from the wall behind, is about 30 ins. high. Although this bench appears as though it might be a separate feature, it is in reality a part of the building itself, having been constructed at the same time as the walls.

Another practical feature is the sanitary drinking fountain, made of glazed cement, which is in the center of the room. The water for this fountain has been piped underground from the old fountain at the Mission, about a hundred yards away. An interesting point about this modern station is that, so far as was practicable, it was built on lines which harmonized with those of the Mission near which it stands. In other words, Spanish and Mission styles were used in its design and construction.

Locomotive Cranes for Track Work

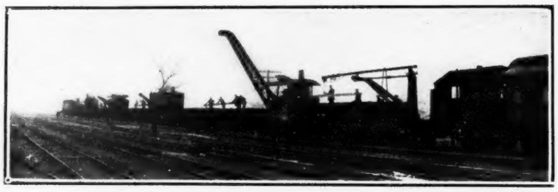
New Method of Laying and Relaying Rail on the Lehigh Valley

The Lehigh Valley Railroad has just announced the purchase of six new locomotive cranes. Aside from the purpose for which they were originally designed, the management and engineers of the Lehigh Valley have found these cranes a good asset in laying rail

Locomotive Cranes on the Lehigh Valley

for new tracks and in picking up old rail. Recently during the congestion at the port terminals, the cranes have also been used with great advantage in the unloading of heavy freight. The Lehigh Valley now has as many as thirty-two of these cranes at work.

During the past year the Lehigh Valley Railroad has made some remarkable records in the loading and unloading of rail by the use of these cranes. The best record was made on a stretch of line between Gilbert and a point east of Lodi, N. Y., when 4.07 miles of track were laid with new 100-lb. rail in remarkably short time. Four locomotive cranes were used. The work was begun at 6.23 A. M., and the last new rail



Rail-laying Train on the Lehigh Valley

was laid at 12.51 P. M., and the track was entirely completed and the old rail and material picked up and loaded on cars at 6:30 p. m. This was done without any interruption to traffic. Our illustrations give a good idea of three of these cranes at work. The work train has a business-like appearance and lives up to its appearance.

A Study of Grade Crossing Elimination in Cities

Digest of Paper Read before Western Society of Engineers by C. N. Bainbridge, Assoc. M. W. S. E., Containing Valuable Tables and Original Information, Constituting a Comprhensive Survey of Grade Separation Work

In general, grade crossings can be eliminated in two ways only, by carrying the tracks over the street, or the street over the tracks. The tracks may be carried across the streets by depressing the streets and leaving the tracks at their original elevation, or by elevating the tracks and leaving the streets at their original elevation, or by a partial elevation of the tracks and a partial depression of the streets. The streets may be carried over the tracks by a full elevation of the streets or by a full depression of the tracks, or by a partial elevation of the streets and a partial depression of the tracks.

In the following discussion, track elevation refers to the case where the tracks are carried across the streets, and track depression refers to the case where the streets are carried over the tracks.

Probably the biggest factor entering into a question of grade crossing elimination is the cost, this being the most vital to the railroads, who generally bear the greater burden of the expense. Practically all questions which arise, where two or more plans present themselves, are determined from this standpoint.

The geological character and topography of the country and the effect on the grade of the railroad are also big factors in selecting a plan for any grade separation project. In a flat low district situated as is Chicago, there is, however, little choice in selecting the method of separation. Track depression would be out of the question on account of difficulties which would be encountered by water and interference with the sewer system which would make the expense prohibitive. This leaves the alternative of track elevation, or partial elevation. Chicago, however, is only one city in many where grade separation is being carried on, and at other places where the tracks are at the summit of an ascending grade, the natural selection would be depression, unless this proved to be too expensive. There are still other places where the ground is high above water and the present tracks nearly level. In such cases either track elevation or track depression could be adopted without excessive gradients.

Numerous elements are involved in the study of a project of this nature and for convenience they will be considered in the following order:

Excavation or fill.
Clearances.
Bridges.
Right of way and retaining walls.
Changes in streets.
Conclusions.

Excavation or Fill

To carry the tracks over the street requires a vertical separation of grades of from 15 ft. 6 in. to 17 ft. 6 in., allowing from 3 ft. 6 in. to 4 ft. for floor depth and 12 ft. to 13 ft. 6 in. for headroom. To carry the streets over the tracks requires a vertical separation of grades of from 21 ft. 6 in. to 26 ft. 6 in., allowing from 18 to 22 ft. for clearance and from 3 ft. 6 in. to 4 ft. 6 in. for floor depth. The difference of from 5 to 11 ft. in the amount of vertical separation of grade, required for complete elevation and complete depression, together with the increased width of roadbed required for track depression over that required for track elevation, in order to provide for drainage, makes the amount of excavation, in the case of track depression, considerably more than the amount of fill required for track elevation. Fig. 1 shows typical cross-sections required for track elevation, and track depression and illustrates the above statement for one and two-track projects. From inspection, it is seen that the excess in yardage of track depression projects increases as the number of tracks increase.

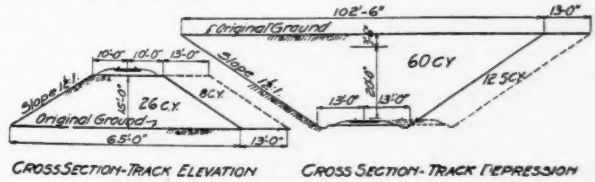


Fig. 1

What appears at first glance to be a decided advantage for track elevation, may, on further study and consideration be an advantage for track depression. This depends largely on the source of material for fill, in the case of track elevation, and the distance it has to be hauled, and where material excavated—in the case of track depression—can be disposed of. Other things being equal, material can be excavated as cheaply in a cut for track depression as in the borrow pit for track elevation; but usually the cost of dumping material for fill will exceed the cost of wasting material from the cut, due to the fact that material for fill is usually dumped from a trestle, and the cost of the trestle is chargeable to the fill. The additional cost of a trestle will go a long way toward balancing the cost of additional yardage required in the project of track depression. This may be best illustrated by an example: Assuming that but one track is to be elevated or depressed, leaving the street in its original position and that the right of way is sufficiently wide so as not to require walls, the cross-sections required are shown in Fig. 1. Assuming further that the cost of material for fill per cu. yd. exclusive of cost of borrow pit and haul, and cost of handling traffic, is as follows:

Loading and shifting track at pit	$ .10
Unloading and distributing from trestle	.06
Trestle at $6 per lin. ft. 600/26	.23
Cost per cu. yd. for fill in place, exclusive of cost of borrow pit and haul and cost of handling traffic	.39

Assuming that the cost of material excavated in the depression per cu. yd. exclusive of haul and cost of land to waste on and cost of handling traffic is as follows:

Loading and shifting track in cut	$ .10
Unloading and distributing	.10
Cost per cu. yd. of material removed from excavation exclusive of haul and cost of land to waste on and cost of handling traffic	.20

From the foregoing it is noted that the cost of 1 cu. yd. of material for fill, exclusive of the items indi-

cated above, is practically twice the cost of 1 cu. yd. of material from the depression, but from Fig. 1, it is noted that the quantity of material from 1 lin. ft. of depression is slightly in excess of twice the quantity of material for 1 lin. ft. of fill, thus making the cost for 1 lin. ft. of depression and 1 lin. ft. of fill approximately the same, exclusive of haul, cost of borrow pit and land on which to waste material, and cost of handling traffic.

Assuming further that the cost of haul is five mills per ton mile and that material weighs 2,500 lb. per cu. yd., the cost of haul per cu. yd. of material would be 0.625 cents per mile.

The cost of hauling material for 1 lin. ft. of embankment one mile 26 x .00625....... $ .1625

The cost of hauling material for 1 lin. ft. of depression one mile 60 x .00625......... .375

These figures indicate that, when the length of haul for material for fill is approximately equal to, or less than, twice the length of haul necessary to waste material from the depression, track elevation is cheaper.

For a two-track proposition the same reasoning holds, and figures indicate that for equal hauls, track elevation is the cheaper if one trestle is used in making the fill, but when two trestles are used, track depression is the cheaper.

It has been assumed in the foregoing comparison that the cost of borrow pit and cost of land to waste material on would be approximately equal and would not enter into the above comparison. This, however, may not always be the case, and the cost of such land should be pro-rated to the estimated yardage for fill and excavation, and the value of the land, after the work is completed, credited to same. It is sometimes the case that a project of grade crossing elimination is carried on to advantage in conjunction with some other project, such as the construction of freight or storage yards, where considerable grading is necessary and material may be borrowed or wasted as the case may be, to good advantage and at small expense.

Further examples could be given, but the ones already cited will illustrate that the question of the source of material to be borrowed and place of disposition of material to be wasted is vital and should be considered for any project. Other items, such as difference in cost of bridges and walls, number of tracks, and cost of maintaining traffic, changes to sewers, and nature of material to be excavated, and depth of depression and amount of elevation will tend to throw the balance either one way or another for any particular case.

Clearances

In recent years numerous state legislatures have passed various laws regarding vertical and side clearances. In some cases the requirements of these laws are more rigid than the present standard clearances of 22 ft. vertical and 7 ft. lateral, maintained by the majority of the railroads. The Minnesota law, one of the most recent ones, requires new tracks to be 14 ft. centers, 1 ft. greater than the present practice, and a side clearance of 8 ft. measured from the center line of track at the base of rail. This is 1 ft. greater than the present bridge clearance standards, 2 ft. 6 in. above the top of rail, and 3 ft. greater at top of rail. The clearance over tracks is fixed at 21 ft., which is not quite as great as the present railroad standard bridge clearance. This is typical of the laws being passed by various legislatures, although some specify but 7 ft. above the highest car for vertical clearance, which would reduce the clearance to about 20 ft. 6 in. In most cases, however, there is a provision in such laws which allows this clearance to be reduced in special cases, if approved by the city or railroad commission. For track depression projects the overhead clearance generally adopted is between 18 and 22 ft., but in some instances where passenger traffic alone is handled on the lines this is reduced to 16 ft., although this latter figure is somewhat scant if electrification is contemplated at some future date.

Where the tracks are elevated, the clearances of the bridge over the street varies in different localities, the usual clearances being 12 to 13 ft. for streets without street cars, and 13 ft. 6 in. to 14 ft. 6 in. for streets with street cars.

The following brief table gives the vertical clearances which have been used in the past for bridges over the tracks and for bridges over the streets in different localities under various conditions. For proposed work there is little variation from the clearances shown for bridges over streets, but there is a strong tendency, as indicated by recent legislation, to increase the clearances under bridges over the track to 21 or 22 ft. wherever possible, unless the railway commission or some other competent authority permits a reduction in special cases.

CLEARANCES IN FEET OF BRIDGES OVER STREET

Location.	Sts. without St. Cars.	Sts. with St. Cars.
Chicago	12 to 13	13.5
Philadelphia	14	14
New York	14, usual, 11 and 12 special	14
Buffalo	13	14
Evanston	12 to 13	13.5
Kansas City	13	14.5
Cleveland	13	14.5
Detroit	13	14
Milwaukee	12	13.5

CLEARANCES IN FEET OF BRIDGES OVER TRACKS

Location.	Clearances.	Clearance. Side
Chicago	16 to 18	....
Philadelphia	20	....
Rhode Island	18	....
Connecticut	18	....
New York City	16 to 18	....
N. Y. State	21	....
Massachusetts	18	....
Buffalo	15 to 18	....
Minneapolis	18 to 18.5	....
North Dakota	21	8
Canada	22.5	....
Kentucky	22	....
Cleveland	16.25	....
New Hampshire	21	....
Michigan	18	....
Minnesota	21	8
Vermont	22	7.5
Indiana	21	7

If legislation governing clearance must come, national legislation is preferable to state legislation. A railroad passing through six or eight states would not then have to conform to as many different laws for clearances, and trainmen would have some knowledge of what to expect in the way of clearances.

Bridges

Bridges for track elevation or track depression projects are in practically all instances of a permanent nature and are constructed of either structural steel or reinforced concrete; or a combination of both. A few of the roads are adopting concrete, wherever possible, to the exclusion of steel in structures of this class, as the first cost is the same as or less than steel, the maintenance is less, and it can be treated aesthetically to better advantage where such treatment is warranted by the nature of the district through which the road passes, such as across boulevards and in residence districts. The same may be said for bridges crossing a depression of the tracks, although the need for aesthetic treatment is probably not so great, because fewer people will view the bridge from close range.

Bridges for track elevation can be divided into four types:

Type A.—Structures spanning the full width of street with single spans.

Type B.—Structures spanning the full width of street with two spans, supports being placed in the center of the street.

Type C.—Structures spanning the full width of street with three spans, supports being placed at the curb lines.

Type D.—Structures spanning the full width of street with four spans, supports being placed at the curb lines and at the center of roadway.

In practically all types it is desirable to:

1st.—Keep the floor of the bridge as thin as possible.

2nd.—Avoid any projections above the top of rail, which might be a menace to safety.

3rd.—Select a type of bridge which can be readily altered to provide for additional tracks.

Bridges of types A, B, and C, except in cases of narrow streets where comparatively short spans can be

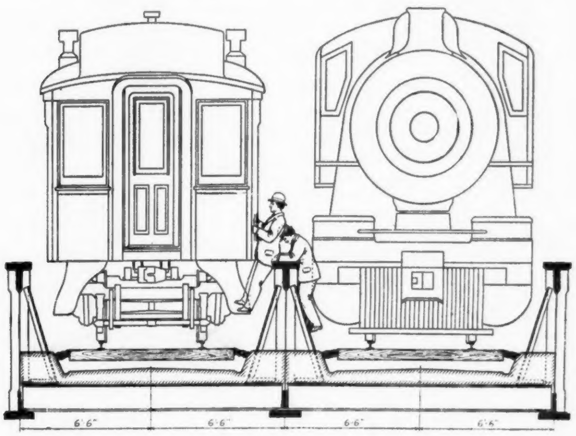


Fig. 2

employed, have no alternative, except the use of steel girders, although they have been used to some extent by resorting to a combination of structural steel and reinforced concrete, but not to the exclusion of the deep side girders. These types, however, have the first qualification of thin floors, but cannot in all cases meet the second qualification of no projections above the top of rail, nor do they meet the third provision for taking care of additional tracks without considerable alteration and expense.

Fig. 2 illustrates how the projections above the bridge floor are a menace to safety, unless sufficient side clearance is maintained by spreading the track which, although an advantage, will increase the cost of the bridge and embankment. Fig. 3 illustrates conditions prevailing when deck type structure of type "D" is permitted.

Bridges of types "B" and "D" have the objection that the roadway is obstructed by the supports in the center of the street, but, with the possible exception of structures spanning boulevards, there is no serious disadvantage in this, provided the roadway on each side of the center supports is of sufficient width to allow two vehicles going in the same direction to pass each other. This objection would be even less for structures spanning streets with double street car tracks, although it requires the spreading of the car tracks. The car tracks themselves form a natural barrier in the center of the street, there being little occasion for traffic across the car tracks from one to the other, especially in the short distance occupied by the bridges.

Bridges of type "D" meet the three requirements of thin floors, no projections above top of rail and ease of alteration to provide for additional tracks. Due to the comparatively short spans, this type is well adapted to be constructed of either steel or concrete.

It has been recognized by practically all parties interested that tight floors are a necessity in bridges crossing city streets, not only to prevent grease, dirt and water from dropping through, but also to deaden the noise of trains passing at high speed across the bridges. Numerous types of floors have been used to accomplish these results, but only two types of floors, i. e., steel I-beams and concrete slabs for steel bridges and the solid slab for concrete bridges, will be considered here. There are numerous modifications of or variations from these selections which might be adopted, the various roads using the one with which they have had the better success, but in all probability floors as used in concrete bridges of type "D" will remain the cheaper.

Structures spanning 60-ft., 66-ft. and 80-ft. streets are compared, these being the usual width of streets in cities.

The relative economy of the various types is shown in the estimates in Figs. 4 to 13.

These relative comparisons for track elevation bridges are on the basis of two track structures for Cooper's E-50 loading with track and girders 13 ft. 0 in. on centers. The depth of floor for the steel structures is 3 ft. 6 in., and for concrete structures 3 ft. 10 in. No account has been taken of the additional cost chargeable to the concrete structure due to the difference in thickness of floors. This would vary, depending on the distance between structures, and whether retaining walls were required to retain the fill between structures. On the other hand, no account has been taken of the additional cost to maintain the steel bridges; it being assumed that the additional cost of maintenance of the steel structure, if capitalized, would offset the cost of the additional fill and walls. Paving and sidewalks have been figured on the basis of the right of way being 100 ft. wide. This may be wider than the majority of right of way, but there will be

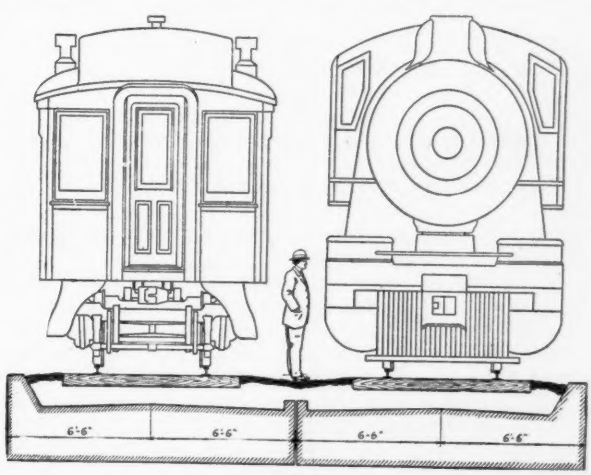
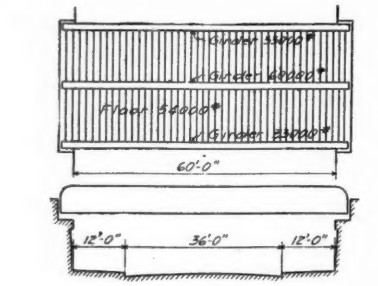


Fig. 3

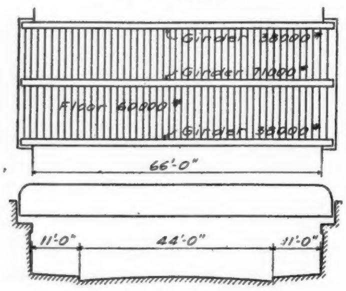
few crossings where at least this amount of paving and sidewalk will not have to be restored. Abutments and pier footings have been figured on the basis that the foundation is good for a load of from 2 to 2.5 tons per sq. ft.

The estimates are intended to represent only the comparative cost of a structure as illustrated. Numerous items, such as rails, ties, ballast, and drainage of subways being common to all structures have not been included, it being assumed that they would vary with the location and conditions under which a structure is built, but that there would be little difference due to the type of structure built.



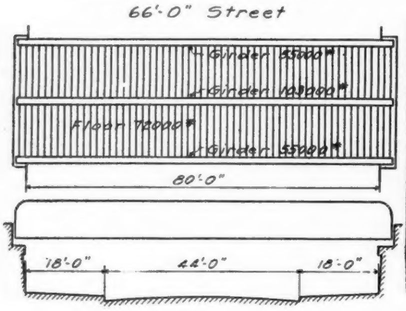
60'-0" Street

Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	180000#	3¢	$5400
Conc Floor	52 C.Y.	$18.00	930
Conc Abut.	530 "	$7.00	3710
Exc. for Abut.	350 "	$1.00	350
Backfill	120 "	25¢	30
Paving on R. of W.	400 S.Y.	$3.25	1300
Sidewalk on R. of W.	2400 S.F.	15¢	360
Waterproof'g	1725 S.F.	20¢	340
Falsework	160 L.F.	$8.00	1280
Eng. & Cont.	20%		$2700
Total			$16,400
Each add. Track costs			$6000



66'-0" Street

Estimate			
Material	Quantity	Unit Cost	Total
Struct Steel	207000#	3¢	$6210
Conc Floor	57 C.Y.	$18.00	1030
Conc Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill	120 "	25¢	30
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	2200 S.F.	15¢	330
Waterproof'g	1900 S.F.	20¢	380
Falsework	172 L.F.	$8.00	1380
Eng. & Cont.	20%		$3000
Total			$18,000
Each add. Track costs			$6700

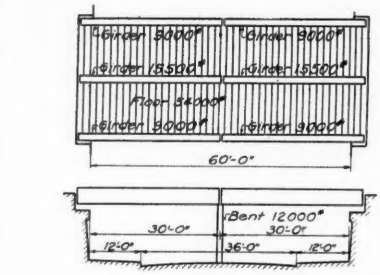


80'-0" Street

Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	285000#	3¢	$8550
Conc Floor	69 C.Y.	$18.00	1240
Conc Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill	120 "	25¢	30
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	3600 S.F.	15¢	540
Waterproof'g	2240 S.F.	20¢	450
Falsework	200 L.F.	$8.00	1600
Eng. & Cont.	20%		$3650
Total			$21,700
Each add. Track costs			$8200

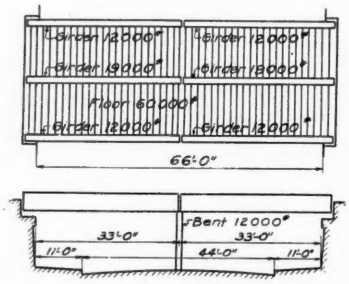
TYPE A. Steel Structures spanning full Width of Street with Single Span

Fig. 4



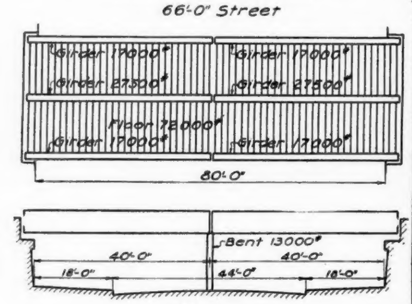
60'-0" Street

Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	133000#	3¢	$3990
Conc. Floor	52 C.Y.	$18.00	935
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footg's	21 "	$8.00	170
Exc. for Pier Footg's	40 "	1.00	40
Backfill for Pier Footg's	20 "	25¢	5
Paving on R. of W.	400 S.Y.	$3.25	1300
Sidewalk on R. of W.	2400 S.F.	15¢	360
Waterproof'g	1725 "	20¢	340
Falsework	160 L.F.	$8.00	1280
Eng. & Cont.		20%	2500
Total			$15000
Each add. Track costs			$5300



66'-0" Street

Estimate			
Material	Quantity	Unit Cost	Total
Struct Steel	158000#	3¢	$4740
Conc. Floor	57 C.Y.	$18.00	1030
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Foot'g's	23 "	$8.00	185
Exc. for Pier Foot'g's.	40 "	1.00	40
Backfill for Pier Foot'g's.	20 "	25¢	5
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	2200 S.F.	15¢	330
Waterproof'g	1900 "	20¢	380
Falsework	172 L.F.	$8.00	1380
Eng. & Cont.		20%	2740
Total			$16,500
Each add. Track costs			$5800



80'-0" Street

Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	208000#	3¢	$6240
Conc. Floor	69 C.Y.	$18.00	1240
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Foot'g's.	26 "	$8.00	205
Exc. for Pier Foot'g's.	50 "	1.00	50
Backfill for Pier Foot'g's.	20 "	25¢	5
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	3600 S.F.	15¢	540
Waterproof'g.	2240 "	20¢	450
Falsework	200 L.F.	$8.00	1600
Eng. & Cont.		20%	3200
Total			$19200
Each add. Track costs			$6900

TYPE B. Steel Structures Spanning full Width of Street with Two Spans

Fig. 5

Bridges for track depression projects may be divided in two main types:

Type E.—Bridges spanning the tracks with clear spans.

Type F.—Bridges spanning the tracks with two or more spans with intermediate supports.

In bridges for track depression as well as for track elevation it is desirable to observe the same conditions, namely:

1st.—Keep the floor of the bridges as thin as possible.

2nd.—Avoid any obstructions between tracks.

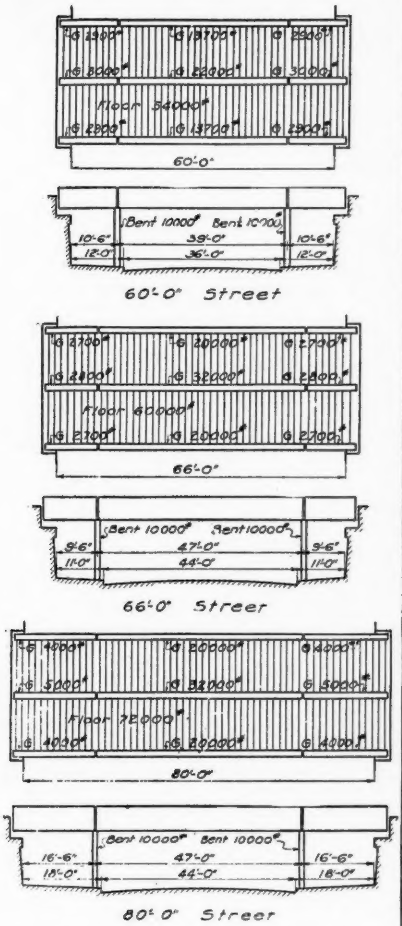
3rd.—Select a type of bridge which can readily be altered to provide for additional tracks.

Bridges of type "E" (bridges with clear spans) meet the first of these requirements, but in most cases not to as good advantage as structures of type "F" with supports between tracks. For streets with narrow roadways and short spans, not exceeding three tracks, a deck type structure of either concrete or steel can be adopted. For longer spans and wide roadways, however, the deck type must give way to the through type with girders projecting above the roadway, and reinforced concrete cannot be used to advantage; but a combination of structural steel and concrete may be used. For narrow roadways but two lines of girders need project above the roadway, one on either side at the curbs; but for wide roadways center girders are required. This is a disadvantage, the same as the center piers in bridges of type "D" (structure spanning the street in four spans with supports at the center of street and at the curbs) for track elevation, but is not serious. Structures of type "E" spanning the tracks with a single span do not lend themselves well to the third requirement, that of additional tracks. Either additional tracks must be provided for when the structure is built, or considerable expense must be incurred to lengthen the bridge to provide for them.

Bridges of type "F" (bridges spanning the track with two or more spans) meet the first requirement of thin floors and the third requirement of providing for additional tracks, but do not meet the second requirement of no obstructions between tracks. This can be overcome by spacing the tracks in pairs at 13 and 18 ft. centers respectively where more than two tracks are used, which will give the required clearances, but will add an item of expense for additional excavation, and, where the right of way is narrow, an item for additional right of way or higher walls. This type of bridge is also well adapted to the use of concrete.

The comparative economy of the various types to meet different conditions is shown in the foregoing estimates:

The foregoing comparisons for track depression bridges are on the basis of 20 ft. 0 in. clearance over tracks at 13 ft. 0 in. centers, except in bridges of type "F" (bridges of two or more spans with intermediate supports) where alternate tracks are widened to 18 ft.



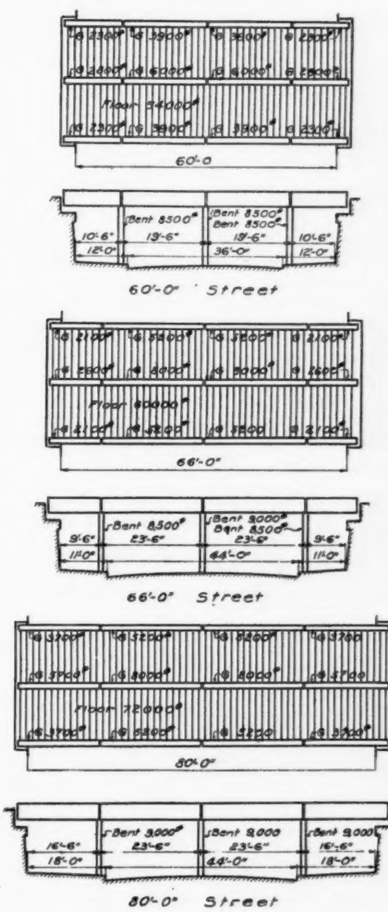
Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	141000#	3¢	$4230
Conc. Floor	52 C.Y.	$18.00	930
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footgs.	37 "	$8.00	300
Exc. for Pier Footgs.	70 "	$1.00	70
Backfill for Pier Footgs.	40 "	25¢	10
Paving on R. of W.	400 S.Y.	$3.25	1300
Sidewalk on R. of W.	2400 S.F.	15¢	360
Waterproofg.	1725 "	20¢	340
Falsework	160 L.F.	$8.00	1280
Eng. & Cont.		20%	2600
Total			$15,500
Each add. Track costs			$5500

Estimate.			
Material	Quantity	Unit Cost	Total
Struct. Steel	168400#	3¢	$5050
Conc. Floor	57 C.Y.	$18.00	1030
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footgs.	42 "	$8.00	340
Exc. for Pier Footgs.	70 "	$1.00	70
Backfill for Pier Footgs.	40 "	25¢	10
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	2200 S.F.	15¢	330
Waterproofg.	1900 "	20¢	380
Falsework	172 L.F.	$8.00	1380
Eng. & Cont.		20%	2840
Total			$17,100
Each add. Track costs			$6000

Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	190000#	3¢	$5700
Conc. Floor	69 C.Y.	$18.00	1240
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footgs.	46 "	$8.00	370
Exc. for Pier Footgs.	80 "	$1.00	80
Backfill for Pier Footgs.	40 "	25¢	10
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	3600 S.F.	15¢	540
Waterproofg.	2240 "	20¢	450
Falsework	200 L.F.	$8.00	1600
Eng. & Cont.		20%	3140
Total			$18800
Each add. Track costs			$6800

TYPE C. Steel Structures Spanning full Width of Street with Three Spans

Fig. 6



Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	121900#	3¢	$3660
Conc. Floor	52 C.Y.	$18.00	930
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footgs.	45 "	$8.00	360
Exc. for Pier Footgs.	80 "	$1.00	80
Backfill for Pier Footgs.	40 "	25¢	10
Paving on R. of W.	400 S.Y.	$3.25	1300
Sidewalk on R. of W.	2400 S.F.	15¢	360
Waterproofg.	1725 "	20¢	340
Falsework	160 L.F.	$8.00	1280
Eng. & Cont.		20%	$2500
Total			$14900
Each add. Track costs			$5100

Estimate.			
Material	Quantity	Unit Cost	Total
Struct. Steel	136400#	3¢	$4090
Conc. Floor	57 C.Y.	$18.00	1030
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footgs.	46 "	$8.05	370
Exc. for Pier Footgs.	80 "	$1.00	80
Backfill for Pier Footgs.	40	25¢	10
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	2200 S.F.	15¢	330
Waterproofg.	1900 "	20¢	380
Falsework	172 L.F.	$8.00	1380
Eng. & Cont.		20%	2660
Total			$16000
Each add. Track costs			5500

Estimate			
Material	Quantity	Unit Cost	Total
Struct. Steel	162000#	3¢	$4860
Conc. Floor	69 C.Y.	$18.00	1240
Conc. Abut.	530 "	$7.00	3710
Exc. for Abut.	340 "	$1.00	340
Backfill for Abut.	120 "	25¢	30
Conc. in Pier Footgs.	51 "	$8.00	410
Exc. for Pier Footgs.	90 "	$1.00	90
Backfill for Pier Footgs.	40 "	25¢	10
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	3600 S.F.	15¢	540
Waterproofg.	2240 "	20¢	450
Falsework	200 L.F.	$8.00	1600
Eng. & Cont.		20%	2930
Total			$17800
Each add. Track costs			$6300

TYPE D Steel Structures Spanning full Width of Street with Four Spans

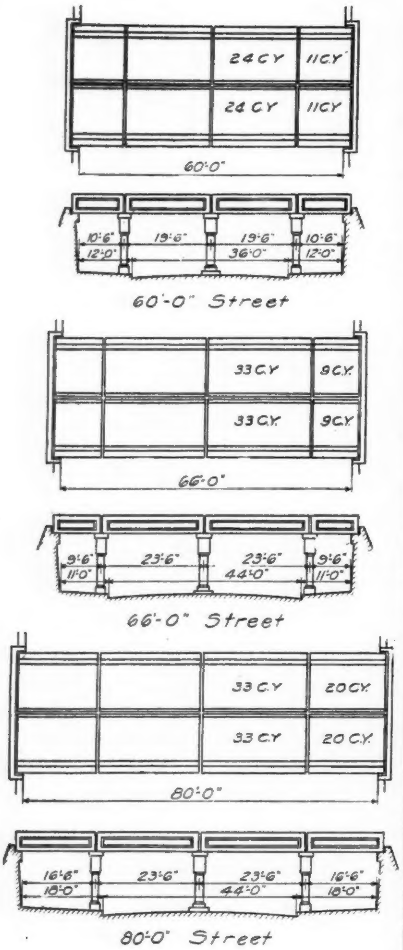
Fig. 7

0 in. centers to provide adequate side clearance. A 24-ton concentrated load on two axles 10 ft. centers and 5 ft. gauge and two 40-ton street cars were assumed as the bridge loads, with 150 lb. per sq. ft. on the portion of the sidewalks and roadway not occupied by the concentrated load and street cars. As it is not a common practice to carry the full width of the street across the depression where the streets are 80 ft. wide, no estimates are shown for this width of street. It is usual for 80-ft. streets to carry only the roadway and two amply wide sidewalks across the depression, reducing the width of street by the amount otherwise occupied by parking. As in the case of the track elevation bridges, paving and sidewalks off the bridge have been figured on the basis of 100 ft. right of way. The estimates are intended to be comparative only, and the same items were omitted as in the case of track elevation bridges.

Ignoring property damages, and, in the case of track elevation, the excavation required for depressing the streets, and in the case of track depression the excavation required for depressing the tracks and the fill required for the street approaches, the cost of a particular type of structure across an assumed 100 ft. right of way remains practically constant, regardless of the elevation to which the tracks are elevated or depressed; i. e., structures of type "D" (bridge spanning the street in four spans) will cost practically the same, ignoring the above item, whether the tracks be elevated 2 ft. or 10 ft. The same is true for any of the other types.

From an examination of the estimates it can be seen that for a two or three track proposition there is little difference between the cost of bridges for elevation and those for track depression. Concrete bridges of type "D" (bridges with supports at curbs and at center of roadway) are the cheapest type for track elevation and concrete bridges of type "E" (bridges spanning tracks with clear spans) are the cheapest for track depression. As the number of tracks increase, however, bridges of type "F" (bridges spanning tracks with two or more spans with intermediate supports) for track depression show a saving over other types of bridges. If the distance between adjacent bridges be great, this may be more than offset by the cost of the additional excavation or higher walls required, by having the tracks spaced at 18 ft. centers to provide sufficient side clearance where supports are located between tracks. The estimates show further that the first cost of concrete bridges, although requiring a slightly deeper floor, are cheaper than steel spans with concrete slabs. It might be said here, that if timber floors were used in place of the concrete slabs for the depression bridges, the cost of such bridges would be reduced below those of reinforced concrete, but on the other hand, if the steel bridges are encased, the difference in cost between the two will be still greater in favor of the concrete bridges.

In track depression bridges of type "E" (bridge spanning tracks with clear span) there is a manifest sav-



Estimate			
Material	Quantity	Unit Cost	Total
Conc. Slab	140 C.Y.	$14.00	$1960
Conc Columns	55 "	$21.00	1155
Col Footgs.	68 "	$8.00	545
Excavation for Col. Footgs.	150 "	$1.00	150
Backfill for Col. Footgs.	60 "	25¢	15
Conc. Abut.	420 "	$7.00	2940
Exc. for Abut.	325 "	$1.00	325
Backfill for Abut.	160 "	25¢	40
Paving on R. of W.	400 S.Y.	$3.25	1300
Sidewalk on R. of W.	2400 S.F.	15¢	360
Waterproof'g	1725 "	20¢	340
Falsework	160 L.F.	$8.00	1280
Eng. & Cont.		20%	2090
Total			$12,500
Each add. Track costs			$4200

Estimate			
Material	Quantity	Unit Cost	Total
Conc. Slab	168 C.Y.	$14.00	$2350
Conc. Columns	55 "	$21.00	1155
Col. Foot'gs.	68 "	$8.00	545
Exc. for Col. Foot'gs.	150 "	$1.00	150
Backfill for Col. Foot'gs.	60 "	25¢	15
Conc. Abut.	420 "	$7.00	2940
Exc. for Abut.	325 "	$1.00	325
Backfill for Abut.	160 "	25¢	40
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	2200 S.F.	15¢	330
Waterproof'g	1900 "	20¢	380
Falsework	172 L.F.	$8.00	1380
Eng. & Cont.		20%	2200
Total			$13,400
Each add. Track costs			$4500

Estimate			
Material	Quantity	Unit Cost	Total
Conc. Slab	212 C.Y.	$14.00	$2980
Conc. Columns	59 "	$21.00	1240
Col. Foot'gs.	76 "	$8.00	610
Exc. for Col. Foot'gs.	170 "	$1.00	170
Backfill for Col. Foot'gs.	65 "	25¢	15
Conc. Abut.	420 "	$7.00	2940
Exc. for Abut.	325 "	$1.00	325
Backfill for Abut.	160 "	25¢	40
Paving on R. of W.	490 S.Y.	$3.25	1590
Sidewalk on R. of W.	3600 S.F.	15¢	540
Waterproof'g	2240 "	20¢	450
Falsework	200 L.F.	$8.00	1600
Eng. & Cont.		20%	2500
Total			$15,000
Each add. Track costs			$5300

TYPE D Concrete Structures Spanning Full Width of Street with Four Spans

Fig. 8

ing, by using the center girder, of between $20 and $30 per linear foot of bridge besides the saving either in the cost of excavation in the cut and reduction in heights of walls where used, or in the amount of fill, paving, etc., on the approaches, depending on whether the tracks are depressed one foot less or the street raised one foot less, due to the decrease in the floor depth.

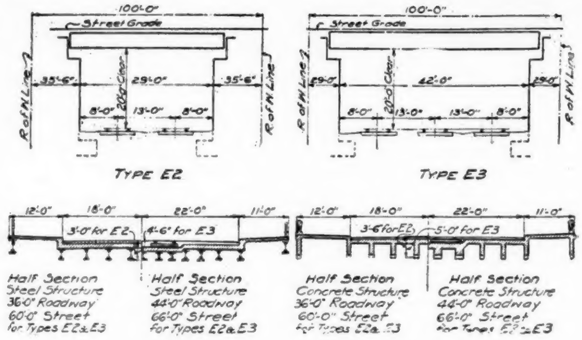
All of the foregoing figures for both track elevation and track depression bridges are applicable only when the tracks cross the streets at right angles, or when they cross at an angle which will not materially increase the span lengths.

For track elevation bridges, where the tracks cross the streets obliquely, or cross at the intersection of two streets, it is desirable, although in some instances difficult without resorting to unsymmetrical and complicated construction, to space the supports so that they line up in the direction of both streets.

Right-of-Way and Retaining Walls

In general, for the same number of tracks in each case, track depression will require a greater width of right of way than track elevation, even where the tracks occupy the full width of right of way and where retaining walls are resorted to.

It is seen from Fig. 1 that the amount of additional right of way required for track depression over that



Estimates - Steel Bridges.									
Material	Unit Cost	Type E2 60'-0" Street 36'-0" Roadway		Type E2 66'-0" Street 44'-0" Roadway		Type E3 60'-0" Street 36'-0" Roadway		Type E3 66'-0" Street 44'-0" Roadway	
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Structural Steel	$.03¼	60,000#	$1950	90,000#	$2920	95,000#	$3080	130,000#	$4220
Conc. Sidewalk on Br.	.40	864 S.F.	345	792 S.F.	320	1180 S.F.	470	1,078 S.F.	430
Conc. Slab on Br.	20.00	36 C.Y.	720	44 C.Y.	880	49 C.Y.	980	60 C.Y.	1200
Reinf. Conc. Abut.	10.00	520 C.Y.	5200	560 C.Y.	5600	520 C.Y.	5200	560 C.Y.	5600
Exc. for Abut.	1.00	600 C.Y.	600	660 C.Y.	660	600 C.Y.	600	660 C.Y.	660
Backfill	.60	720 C.Y.	430	800 C.Y.	480	720 C.Y.	430	800 C.Y.	480
Handrail	1.50	80 L.F.	120	80 L.F.	120	105 L.F.	160	105 L.F.	160
Paving on Br.	2.25	144 S.Y.	320	174 S.Y.	390	196 S.Y.	440	240 S.Y.	540
Paving on R. of W. but off Bridge	3.25	254 S.Y.	825	312 S.Y.	1030	204 S.Y.	665	250 S.Y.	810
Sidewalk on R. of W. but off Bridge	.15	1536 S.F.	230	1408 S.F.	210	1220 S.F.	185	1,122 S.F.	170
Eng. & Cont.	20%		2160		2490		2480		2830
Totals			$12,900		$15,100		$14,700		$17,100

Estimates - Conc Bridges

Conc. Floor	$22.00	100 C.Y.	$2200	130 C.Y.	2860	165 C.Y.	$3630	190 C.Y.	$4180
Reinf. Conc. Abut.	10.00	475 C.Y.	4750	515 C.Y.	5150	475 C.Y.	4750	515 C.Y.	5150
Exc. for Abut.	1.00	600 C.Y.	600	660 C.Y.	660	600 C.Y.	600	660 C.Y.	660
Back Fill	.60	720 C.Y.	430	800 C.Y.	480	720 C.Y.	430	800 C.Y.	480
Paving on Br.	2.25	144 S.Y.	325	174 S.Y.	390	180 S.Y.	405	220 S.Y.	500
Paving on R. of W. but off Bridge.	3.25	254 S.Y.	825	312 S.Y.	1030	220 S.Y.	715	270 S.Y.	880
Sidewalk on R. of W. but off Bridge	.15	1536 S.F.	230	1408 S.F.	210	1320 S.F.	200	1210 S.F.	180
Handrail	2.25	80 L.F.	180	80 L.F.	180	105 L.F.	230	105 L.F.	230
Eng. & Cont.	20%		1860		2240		2240		2440
Totals			$11,400		$13,200		$13,200		$14,700

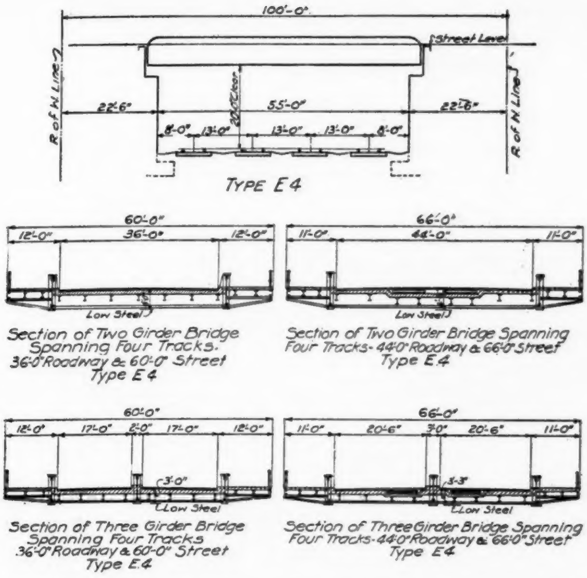
TYPE E2 - STRUCTURES SPANNING 2 TRACKS WITH SINGLE SPAN
TYPE E3 - STRUCTURES SPANNING 3 TRACKS WITH SINGLE SPAN

Fig. 9

required for track elevation, if no retaining walls are used, depends on the amount of elevation and depression of the tracks.

In cases where the entire right of way is occupied by tracks retaining walls would be required for both track elevation and track depression. In such cases it is seen from Fig. 14 that it is necessary to acquire additional right of way to accommodate the same number of tracks in depression as in elevation, or else eliminate one track to allow room for the retaining walls, which must be built on railroad property. The loss due to the elimination of one track to the railroad company is impossible to determine. An order of any city or commission calling for track depression under such circumstances, in the face of the railroad's opposition, amounts to confiscation of railroad property without compensation and without due process of law, and it is doubtful if it would be upheld in the courts.

Both of these conditions are serious handicaps for track depression, for in the majority of cases the districts where grade separation is required are usually thickly settled and the tracks are lined with industries or other improvements, making the acquisition of additional right of way out of the question on account of the value of adjacent property, and leaves the building of retaining walls the only alternative. This would very often be the governing factor in the selection of a plan were the choice made entirely from the economic standpoint, unless the cost of walls be offset by the saving in the cost of track depression bridges over those for track elevation, and in some cases by the saving in the cost of excavating the material for the cut over the cost of filling the embankment.

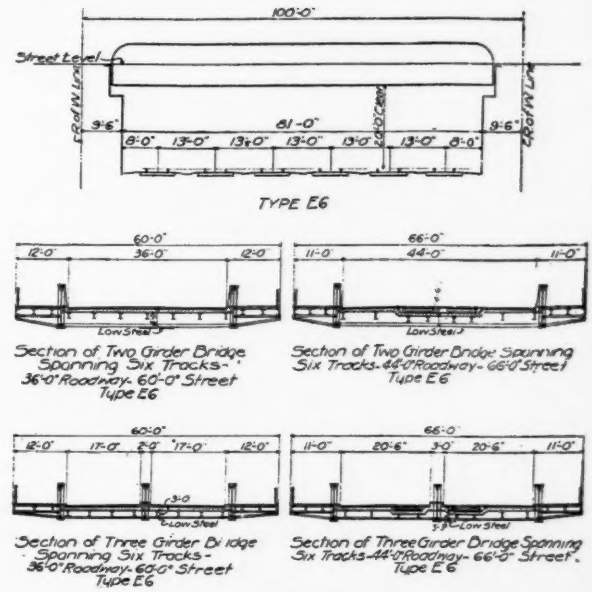


ESTIMATES

Material	Unit Cost	Type E4-2 Girders 60'-0" Street 36'-0" Roadway		Type E4-3 Girders 60'-0" Street 36'-0" Roadway		Type E4-2 Girders 66'-0" Street 44'-0" Roadway		Type E4-3 Girders 66'-0" Street 44'-0" Roadway	
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Structural Steel	$ .03¼	166,000#	$ 5395	127,000#	$ 4130	238,000#	$ 7735	180,000#	$ 5850
Concrete Sidewalk on Bridge	.40	1200 S.F.	480	1200 S.F.	480	1080 S.F.	430	1080 S.F.	430
Conc. Slabs on Br.	20.00	67 C.Y.	1,340	74 C.Y.	1,480	80 C.Y.	1,600	85 C.Y.	1,700
Reinf. Conc. Abut.	10.00	520 C.Y.	5200	520 C.Y.	5200	560 C.Y.	5600	560 C.Y.	5600
Exc. for Abut.	1.	600 C.Y.	600	600 C.Y.	600	660 C.Y.	660	660 C.Y.	660
Backfill	.60	720 C.Y.	430	720 C.Y.	430	800 C.Y.	480	800 C.Y.	480
Handrail	1.50	130 L.F.	200	130 L.F.	200	130 L.F.	200	130 L.F.	200
Paving on Br.	2.25	240 S.Y.	540	220 S.Y.	495	295 S.Y.	665	275 S.Y.	620
Paving on R. of W. but off Bridge	3.25	160 S.Y.	520	160 S.Y.	520	195 S.Y.	630	195 S.Y.	630
Sidewalk on R. of W. but off Br.	.15	960 S.F.	145	960 S.F.	145	880 S.F.	130	880 S.F.	130
Eng. & Cont.	20%		2950		2720		3570		3300
Totals			$17,800		$16,400		$21,700		$19,600

TYPE E4-STEEL STRUCTURES SPANNING FOUR TRACKS WITH SINGLE SPAN

Fig. 10



ESTIMATES

Material	Unit Cost	Type E6-2 Girders 60'-0" Street 36'-0" Roadway		Type E6-3 Girders 60'-0" Street 36'-0" Roadway		Type E6-2 Girders 66'-0" Street 44'-0" Roadway		Type E6-3 Girders 66'-0" Street 44'-0" Roadway	
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Structural Steel	$ 0.03¼	300,000#	$ 9,750	240,000#	$ 7,800	410,000#	$ 13320	324,000#	$ 10,530
Concrete Sidewalk on Bridge	0.40	1,800 sq ft	720	1,800 sq ft	720	1,584 sq ft	630	1,584 sq ft	630
Concrete Slabs	20.00	100 cy	2,000	110 cy	2,200	117 cy	2,340	124 cy	2,480
Reinforced Conc. Abutment	10.00	540 C.Y.	5,400	540 C.Y.	5,400	580 C.Y.	5,800	580 C.Y.	5,800
Exc. for Abut.	1.00	620 cy	620	620 cy	620	680 cy	680	680 cy	680
Back Fill	.60	750 cy	450	750 cy	450	830 cy	500	830 cy	500
Handrail	1.50	200 lin ft	300	200 lin ft	300	200 lin ft	300	200 lin ft	300
Paving on Br.	2.25	360 sq y	810	330 sq y	740	430 sq y	970	400 sq y	900
Paving on R. of W. but off Bridge	3.25	14 "	45	14 "	45	59 "	191	59 "	191
Sidewalk on R. of W., but off Br.	.15	240 "	35	240 "	35	528 "	79	528 "	79
Eng. & Cont.	20%		4070		3690		4990		4410
Totals			$24200		$22000		$29800		$26500

TYPE E6-STEEL STRUCTURES SPANNING SIX TRACKS WITH SINGLE SPAN

Fig. 11

There may, however, be instances where the tracks run through a strictly residence district, where land values would not be excessive and additional right of way could be acquired for a nominal figure, but this condition would be the exception rather than the rule.

Any one of numerous types of retaining walls may be adopted on any project, economy being the prime factor in the selection.

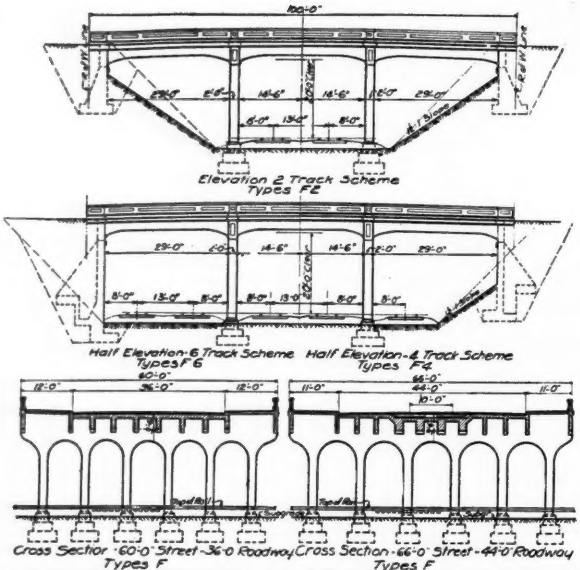
Much literature has been published regarding the economy of various types of walls, and this phase of the subject will not be discussed further than to state that for walls of the height required for track elevation and track depression a gravity wall will, under ordinary conditions, be cheaper than the reinforced concrete types. The following curves, Fig. 15, will serve to indicate the comparative costs per linear foot for various heights of wall for track elevation and track depression for various distances of track from right of way lines.

In compiling these curves, the most severe case has been assumed, in that all walls have been figured to be wholly within the right of way. Some economy can be gained, especially in the high wall where a toe is allowed to extend beyond the right of way, as is generally permitted where there is a street or alley parallel to and adjacent to the right of way. The unit prices assumed are indicated in the figure.

Figure 16 will serve to indicate comparative costs, per linear foot of right of way, of fill and walls for various heights of track elevation, and of excavation and walls for various depths of track depression, for one, two, three, and four tracks on 60, 66, and 100 ft. rights of way, under the following assumptions:

For track elevation it was assumed that fill would be made up to 9 ft. in height by raising the track by depositing material along either side of the track and jacking it a foot or so at a time and tamping the material under the tracks. For heights above 9 ft. it was assumed that but one trestle would be built whether one or more tracks are elevated. The limit of 9 ft. was obtained in the following manner: It was assumed that the ordinary city block is approximately 300 ft. long; this would allow the tracks to be raised 9 ft., by using a 3 per cent grade, without crossing any of the streets. At the streets it was assumed that trestles would be so built as to later permit the construction of bridges without blocking traffic. If the tracks were raised to heights above 9 ft. in short blocks, it would mean that one or more streets would have to be blocked while the tracks were being raised, either by cribbing or filling, and then after the tracks were at the final elevation the fill or cribbing would be removed and a trestle built. This, however, would cause double work at each street, the expense of which would in all probability pay for the additional cost of building the trestle the entire length of the elevation.

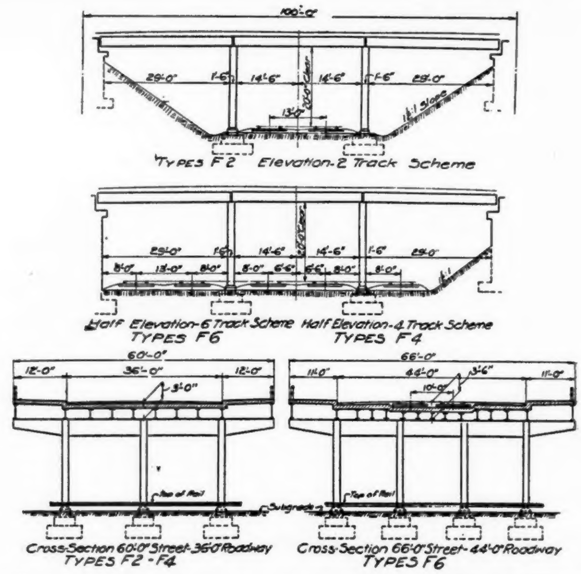
For track depression it was assumed that the shovel would remove the earth within the dotted lines indi-



ESTIMATES													
MATERIAL	Unit Cost	Type F2 60'-0" Street 36'-0" Roadway		Type F2 66'-0" Street 44'-0" Roadway		Type F4 60'-0" Street 36'-0" Roadway		Type F4 66'-0" Street 44'-0" Roadway		Type F6 60'-0" Street 36'-0" Roadway		Type F6 66'-0" Street 44'-0" Roadway	
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Conc. Floor	$22.00	280 C.Y.	$6,160	360 C.Y.	$7,920	280 C.Y.	$6,160	360 C.Y.	$7,920	280 C.Y.	$6,160	360 C.Y.	$7,920
Conc. Col. Steel work	23.00	34 "	780	40 "	920	34 "	780	40 "	920	34 "	780	40 "	920
" " Footings	8.00	60 "	480	74 "	590	60 "	480	74 "	590	60 "	480	74 "	590
Reinf. Conc. Abut.	10.00					330 "	3,300	360 "	3,600	474 "	4,740	515 "	5,150
Plain " "	7.00	210 C.Y.	1,470	230 C.Y.	1,610								
Exc. for Abut. & Col. Footgs.	1.00	1200 "	1,200	1340 "	1,340	1480 C.Y.	1,480	1640 C.Y.	1,640	830 C.Y.	830	940 C.Y.	940
Back Fill	.60	550 "	330	600 "	360	1100 "	660	1200 "	720	1380 "	830	1500 "	900
Paving on Br.	2.25	380 S.Y.	850	460 S.Y.	1,040	380 S.Y.	850	460 S.Y.	1,040	380 S.Y.	850	460 S.Y.	1,040
Paving on R of W. but off Br.	3.25	20 "	60	30 "	100	20 "	60	30 "	100	20 "	60	30 "	100
Sidewalk on R of W. but off Br.	.15	132 S.F.	20	120 S.F.	20	132 S.F.	20	120 S.F.	20	132 S.F.	'20	120 S.F.	20
Handrail	2.25	200 L.F.	450	200 L.F.	450	200 L.F.	450	200 L.F.	450	200 L.F.	450	200 L.F.	450
Eng. & Cont.	20%		2,400		2,850		2,860		3,400		3,000		3,570
Totals			$14,200		$17,200		$17,100		$20,400		$18,200		$21,600

TYPE F - CONCRETE STRUCTURES SPANNING 2, 4 & 6 TRACKS WITH THREE SPANS

Fig. 12



ESTIMATES													
	Unit Cost	Type F2 60'-0" Street 36'-0" Roadway		Type F2 66'-0" Street 44'-0" Roadway		Type F4 60'-0" Street 36'-0" Roadway		Type F4 66'-0" Street 44'-0" Roadway		Type F6 60'-0" Street 36'-0" Roadway		Type F6 66'-0" Street 44'-0" Roadway	
		Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Struct. Steel	$.03¼	215000#	$6990	315000#	$10240	215000#	$6990	315000#	$10240	215000#	$6990	315000#	$10240
Conc. Sidewalk on Br.	.40	2400 S.F.	960	2200 S.F.	880	2400 S.F.	960	2200 S.F.	880	2400 S.F.	960	2200 S.F.	880
Conc. Slab	22.	100 C.Y.	2200	165 C.Y.	3630	100 C.Y.	2200	165 C.Y.	3630	100 C.Y.	2200	165 C.Y.	3630
Conc. Col. Foot'gs	8	40 C.Y.	320	50 C.Y.	400	40 C.Y.	320	50 C.Y.	400	40 C.Y.	320	50 C.Y.	400
Reinf. Conc. Abut.	10.					330 C.Y.	3300	360 C.Y.	3600	474 C.Y.	4740	517 C.Y.	5170
Plain Conc. Abut.	7.	210 C.Y.	1470	230 C.Y.	1610								
Exc. for Abut. & Col. Footgs	1.	1100 C.Y.	1100	1240 C.Y.	1240	1380 C.Y.	1380	1540 C.Y.	1540	730 C.Y.	730	840 C.Y.	840
Backfill	.60	500 C.Y.	300	550 C.Y.	330	1100 C.Y.	660	1200 C.Y.	720	1380 C.Y.	830	1500 C.Y.	900
Paving on Br.	2.25	380 S.Y.	855	460 S.Y.	1030	380 S.Y.	855	460 S.Y.	1030	380 S.Y.	855	460 S.Y.	1030
Paving on R of W. but off Br.	3.25	20 S.Y.	65	30 S.Y.	100	20 S.Y.	65	30 S.Y.	100	20 S.Y.	65	30 S.Y.	100
Sidewalk on R of W. but off Br.	.15	132 S.F.	20	120 S.F.	20	132 S.F.	20	120 S.F.	20	132 S.F.	20	120 S.F.	20
Handrail	1.50	200 L.F.	300	200 L.F.	300	200 L.F.	300	200 L.F.	300	200 L.F.	300	200 L.F.	300
Eng. & Cont.	20%		2920		3920		3450		4540		3590		4690
Totals			$17,500		$23,700		$20,500		$27,000		$21,600		$28,200

TYPE Fs - STEEL STRUCTURES SPANNING 2, 4 & 6 TRACKS WITH THREE SPANS

Fig. 13

cated on the figure and the remainder would be removed at the time, or after the walls are built.

The unit prices used for excavation, fill and trestle are as indicated in the figure; the unit prices for walls are the same as those shown on Fig. 15 for comparative cost of walls. No item has been included to take care of the traffic, which would depend on the density and location.

Change in Grade of Streets

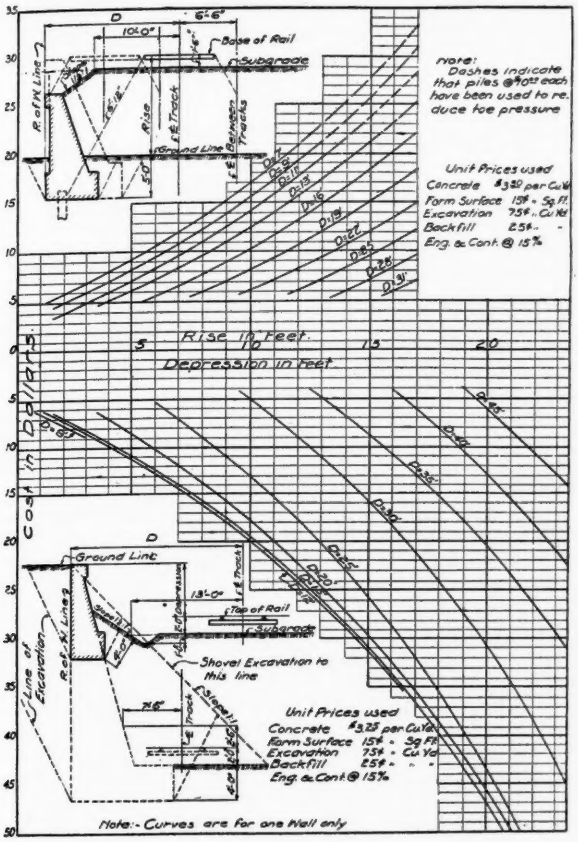
So far only complete elevation and complete depression of the tracks have been considered, which require very little change in the grades of the streets. The question immediately arises as to whether or not a partial elevation of the tracks with a partial depression of the street, or a partial depression of the tracks with a partial elevation of the streets, would not be the plan to adopt. It might be said here that on practically all projects for complete track elevation or depression the plans usually provide for at least a slight change in grade of the street, varying from 1 ft. to 3 ft., which change can readily be made without incurring excessive expense or property damage. It may also be said that to change the grade of the street entirely without changing the railroad track, except in the case of isolated crossings or in country districts is unusual.

To change the street grade any appreciable amount brings up a number of questions: namely, allowable grades on streets, economy, drainage and interference with sewers, gas and water mains, and property damages.

Considerable discussion always arises as to what maximum grades are allowable where the grade of the street is changed. Chicago, where probably more money has been expended for grade separation work than any other city in the country, has fixed by ordinance a maximum grade of 3 per cent. To adopt this grade, however, in all cities would be unquestionably in error, especially so in a hilly city, where existing street grades of from 6 to 8 per cent are not uncommon.

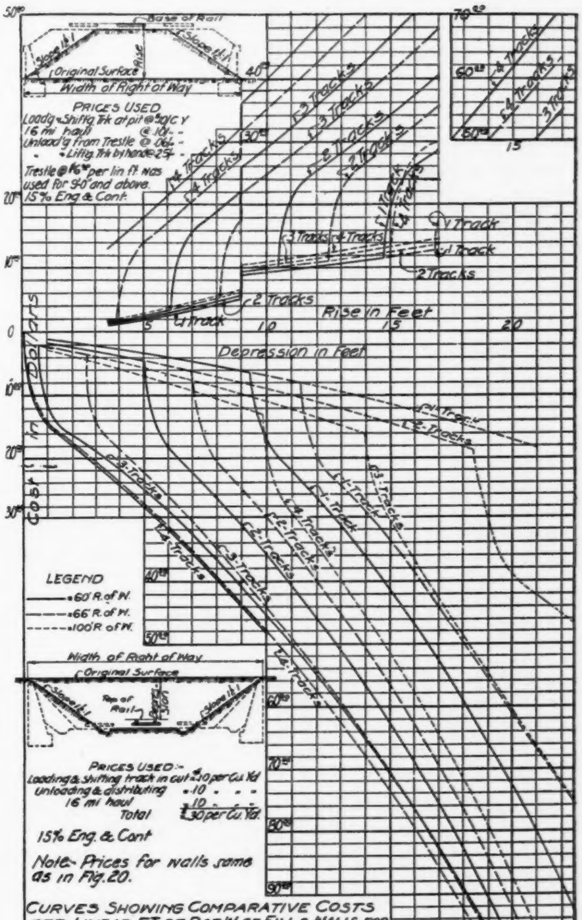
Although most cities try to limit the allowable grades to 3 per cent or 4 per cent, the following table gives some of the grades which have been used on work of this nature in various cities:

Location.	Maximum Grade.
Chicago	3½%, usual 3%
Buffalo	4%
Joliet, Ill.	3½%
Evanston	3½% or 3%
Milwaukee	4%
Minneapolis	5%, 4%, usual 3%
Cleveland	6%, usual 4%
Detroit	4%, usual 3%
Philadelphia	5½, usual 3%
Indianapolis	4½, usual 3%
Lynn, Mass	3%, 4%, and 5%
Brockton	9%, 5%
Washington	9%, 8%, 6%, usual 3%, 4%
Newton, Mass.	9%, 8½%, 7½%, 6%, usual 3% and 5%



Curves showing comparative cost of Walls of various heights for track elevation and track depression with various distances of track from R of W. Line.

Fig. 14



CURVES SHOWING COMPARATIVE COSTS PER LINEAR FT. OF R OF W OF FILL & WALLS FOR VARIOUS HEIGHTS OF ELEVATION AND OF WALLS & EXCAVATION FOR VARIOUS DEPTHS OF DEPRESSION FOR ONE, TWO, THREE AND FOUR TRACKS ON 60', 66', AND 100' RIGHT OF WAYS

Fig. 15

The most rational manner of determining grades to be used would be to take the maximum existing street grade of the thoroughfare of which the street to be changed is a part, or in the case of comparatively flat country, adopt a minimum grade of 3 per cent to 4 per cent, depending on the character of traffic frequenting the streets, and the length of approaches. In special cases exceptions could be made and a slightly steeper grade than ordinarily used could be permitted for a short distance, in order to avoid interfering with the grade of adjacent intersecting streets. This would often materially reduce the construction cost and obviate considerable property damages, and the slight increase in grade for the short distance would not seriously affect teaming.

The level portion of the street where carried under the tracks should extend far enough beyond the portal of the subway so that loads of maximum height will not encroach on the vertical clearances when starting up the approaches. Where the rate of change in grade exceeds 6 ins. in 100 ft., vertical curves extending 15 or 20 ft. on each side of the intersection should be adopted

Where the street is to be carried over the tracks, the sidewalk and roadway must be elevated the same amount, but where the street is carried under the tracks the roadway is sometimes depressed 4 or 5 ft. further than the sidewalk at the deepest part. This has the disadvantage of having high curbs, but where wagons would back up to property adjacent to right of way for loading or unloading it would be an advantage. It also has the additional advantage of producing a smaller actual damage to property, as very often the sidewalks can be left at their original level and the streets depressed 4 or 5 ft. and the tracks elevated the remainder. If, however, this method is carried to extremes and the elevation of sidewalk and street differ to any great extent at the adjacent cross streets, steps are required to get from the street to the sidewalk, which is a decided disadvantage.

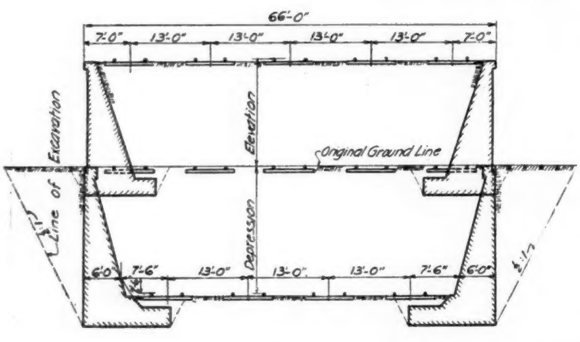
At first glance it would be natural in most projects to say that the less the grade of the tracks is changed the less the project will cost. This, however, is not always the case. Streets may occur with such frequency that the cost of excavation or filling streets, the cost of repaving streets and sidewalks, alterations to sewers and water pipes, and property damaged, will be equal to or greater than the cost of excavating or filling the embankment for track elevation or depression.

Wherever streets are depressed adequate provision should be made for drainage. In some cases where proper provisions have not been made, the streets are flooded and traffic blocked. Catch basins with proper connections to sewers should be placed some distance outside of the portal of the bridge so that in winter or spring time, when the thaw starts, they will not be

in the shadow of the bridge and remain frozen. Similar provision and precaution to provide for drainage should be exercised in the cut in the case of track depression.

In cases where the streets or tracks are depressed to such an extent as to interfere with sewers, the problem is much more complicated. Either new sewers must be constructed at a lower level or else the sewerage will have to be siphoned. Both of these schemes entail considerable expense and are serious handicaps to track depression.

Interference with the water and gas mains is a less serious objection, the question of gradients there being



TYPICAL CROSS SECTIONS OF 66'-0" R OF W. FOR TRACK ELEVATION AND TRACK DEPRESSION WHERE FULL WIDTH OF R OF W IS UTILIZED

Fig. 16

a secondary consideration. Although it adds quite an item to construction cost, provision can be made to carry them across the bridge or floor, or depress them under the cut.

The question of property damage is one for which it is impossible to lay down any set rule. There are many things both imaginary and real for which property owners claim damages when a project of this nature is being executed. In making allowance for this phase of the question, each problem will have to be handled separately, the damages estimated and an amount allowed which would be sufficient to put the property back into as good a condition or perhaps better condition than previously existed. It will be found, in a good many cases where damages are settled out of court, that considerable saving can be effected by buying the property damaged and selling again after the work is completed.

Conclusions

It has not been the writer's intention that this paper should represent a technical study of the grade separation question. Although portions of it deal purely with the engineering side of the question, the primary object has been to set forth, in a general way, some of the questions which will arise in considering a problem of this nature. The question is of such magnitude that it is impossible to cover fully and completely all the questions which arise; no two projects are alike; all have peculiarities of their own, and special features must be dealt with as they arise. From the foregoing considerations, however, it may be said in a general way that track elevation is more satisfactory than track depression, both to the railroads and to the industries having side track connections located along the right of way, and at the same time the former possesses many advantages to the city. With the possible exception of cases where the tracks pass through a high class residence district where the aesthetic appearance is of such importance as to outweigh the other factors, track elevation would appear to be the best solution of the problem.

Securing Maintenance Labor on M., K. & T.

By L. F. LONNBLADH, Chief Engineer

The greater number of our laborers are obtained from local points along the lines but for extra gangs we receive a large number from Kansas City and St. Louis, also Mexican labor from Houston and San Antonio.

These men are hired through private labor agencies, except where obtained locally. No company man is kept at the private labor agencies to accept shipments of men.

A certain number of the track men are employed permanently and the forces increased as work may require. Section houses or boarding cars are furnished the men as required.

In promotion the efficiency of the particular man is what governs our choice. Generally the laborers who are efficient and take interest in the work are promoted to foremen.

I believe that maintenance could be bettered by having an apprentice on every section and paying him a slight increase in wages above that paid the ordinary track laborer. Then in case of vacancy in the foremanship the position should be filled from these apprentices, seniority and qualifications governing.

In connection with this outline I wish to say a few words about the class of labor which is very aggravating to a foreman in a great many cases, but some foremen make their conditions far worse than they should be. A foreman should do the best he can with what he has to do it with, and I know many of them that will get good results from foreigners where others can accomplish nothing. A foreman should be firm in his discipline to his men and yet be loyal to them, and he should be a very good judge of mankind. What can be said to one man with profit cannot be said to another and a foreman should take all this into consideration. In this way he will get the very best results from the efforts of each man.

Any roadmaster or supervisor knows when he gets a first class corps of section foremen, and his troubles are diminished to quite an extent by so doing. A foreman should study his men and acquaint each one with the particular kind of work to which he is fitted and insist that he systematize his work so as to keep his section in as near as possible perfect shape.

First Aid Saved Limb

The value of first aid instruction in big industrial plants has already been demonstrated. An accident on the Grand Trunk Railway resulted in one of the men having his right leg broken in two places. The case was handled by the G. T. R. first aid class, and on the patient reaching the hospital the surgeons called in the whole nursing and student staff to see the manner in which the splints and bandages had been applied. The doctors stated that if the man had been moved without this expert care there would have been a very serious chance of his losing the limb or of his becoming lame for life.

The article on page 10 of our January issue on the "Formation and Prevention of Pockets and Soft Places" was credited to C. A. Davis in error. It should have been Mr. D. C. Davis.

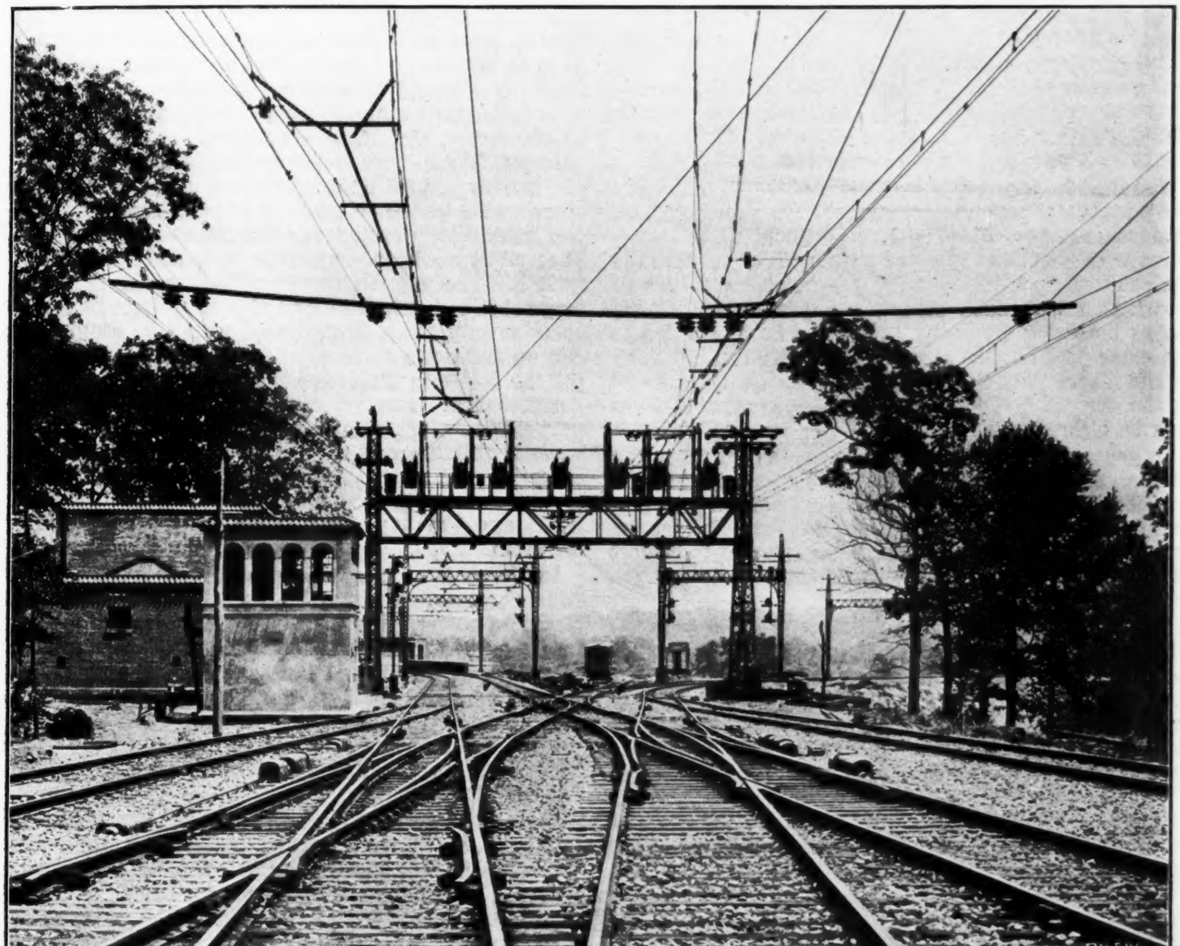
Principles of Railway Block and Interlocking Signals

The Safety Factor in Signal Design. Interlocking as an Aid to Traffic and to Increasing the Capacity of a Railroad

The important and interesting subject of Railway Signaling has recently been very fully and instructively dealt with by Mr. Harold McCready of New York in a paper presented to the Richmond Railroad Club. In it he disclaimed any intention of minutely covering the entire subject, but described briefly the principles which are involved in correct signaling, and he described apparatus which is considered as standard in this country.

Safety First has been the watchword of the signal designer, and the accomplishment of this arrangement is made so that if any part of the apparatus fails or breaks or if the wires become disconnected or broken, the signal goes to "danger." Those not familiar with the mechanism or with the conditions to be met, are apt to consider the whole system unnecessarily complicated. Telephone engineers have pointed out what were to them obvious improvements in the parts of the mechanism. They have intimated that the signal relays might be made cheaper, but in so doing they have overlooked the fact that the signal engineer has often to sacrifice good designs in order to obtain maximum safety.

A first class signal system must aid traffic and not impede it. The frequent failure of the signal apparatus, even if the semaphore blade assumes the stop position, does not get trains over the road. Delays result, and a want of confidence in the efficacy of the system is engendererd. Signals are designed first for safety and second to keep trains moving. They also contribute to the maximum use of track, and so considerably increase the volume of traffic that can be moved.



Example of Power Interlocking Plant on the New York, Westchester & Boston Railroad

Signaling on railways naturally divides itself into two main branches. These are interlocking signals and automatic block signals. The American Railway Association defines the interlocking system as "An arrangement of switch, block and signal appliances so interconnected that their movements must succeed each other in predetermined order." An interlocking machine

consists of a group of levers concentrated at a central point for operating certain switches and signals and so arranged as to interlock such levers as to make it impossible to give clear signals for conflicting routes.

Interlocking plants are installed, for example, where tracks converge, as at a "Y," and they are intended to prevent a clear signal being given for an obstructed track. They prevent false moves. In the example of the "Y" suppose the vertical leg to represent the main line, and the arms of the letter the converging tracks. On each of the two converging tracks, a signal is placed to govern movements of trains to the main track, or vertical leg of the "Y." A two-arm signal placed on that main track governs a movement from the main line into one or other of the branches. The upper arm of this signal governs admission to, say, the right hand branch track, while the lower arm controls admission to the left hand branch track from the main line. It is necessary that, before one of the signals on a branch track may be cleared, the signal on the other branch track must be at "danger," because otherwise two trains might converge simultaneously on the main from the two arms of the "Y." Finally, neither of the signals on the branch tracks should be cleared until the switch at the crotch of the "Y," where the main and two sidetracks join, has been set in the right position.

The interlocking machine is the device which governs and protects train movements under such circumstances. In purely mechanical interlockings, the machine is provided with a number of levers, from which operate the various switches and signals, and these levers are so interlocked with each other as to prevent conflicting routes both showing clear by signals being thrown to the clear position at the same time. The interlocking of the levers is such as to require the switches to be in the correct position before signals governing them may be cleared.

In general, a separate lever is provided for actuating each signal switch. In interlocking plants the normal position of all signals is stop, the semaphore arm projecting horizontally from the signal mast. When the arm is pulled down or allowed to go up so as to project at an angle from the mast, it indicates clear and the train may proceed.

Before the signal may be pulled clear, the switches which it governs must all be thrown to the right position, and they must be locked. The movement of the switch lever to throw the switch to the normal position or the main track does not release the signal lever; that is only half the operation. A second lever is provided for each switch to lock it. This second lever actuates a detector bar. This is a flat bar lying close along the rail and rising above the top of the rail during the time occupied in shifting the lever. When the lever is put home the detector bar sinks below the rail level again. The object of the detector bar is to prevent the switch lever being used while a train is passing over switch. If it was not for this it would be possible for the towerman to move the switch and so "split" the train with disastrous results. In placing the switch it is first unlocked by the lock lever, it is then thrown by the actuating lever. It is then locked and the signal lever completes the operation by indicating the route. These levers cannot be moved indiscriminately, they must follow in regular order, so that the sequence of events may be preserved.

Such a plant as this is described as mechanical interlocking. In it switches and signals are moved by levers. After a switch is thrown to the normal or to the reverse position it is locked by a simple plunger locking arrangement. The signals in a mechanical interlocking plant may be operated by pipe or wire connection, between the lever and the signal itself. If the signals were, say, 2,000 ft. distant, the operation of a long pipe would present serious difficulties on account of friction.

Mechanical interlocking plants for simple track layouts are undoubtedly the simplest and cheapest, and the best for that kind of work. For example, where there is an ordinary crossing of two single track roads, simple hand pulled signals are provided governing movements in either direction on each road, there being two signals on each line. In order to allow a train to pass over the crossing on one track, the corresponding signal is cleared for that track, and the pulling of that signal lever automatically locks the levers controlling the signals on the other track and the opposing signal on the same track, so that only one and not all four signals can be cleared at a time.

If a large and complicated terminal track layout is concerned, involving 20 or 30 tracks, a mechanical interlocking plant is inadequate; because one lever would have to be provided for moving each switch, and another lever would be required for locking the switch. In a track layout of 100 single switches, there would be 200 levers, and if, in addition, there were 100 signals, 300 levers in all would be required. These levers are usually spaced 5 ins. centers and a 300-lever machine would be 125 ft. long. It is plain that a mechanical interlocking system for complicated layouts is an impossibility. It is impossible because it is impracticable. The interlocking machine would require a long cabin to house it in, and at a complicated terminal space is precious. Several men would be required to run up and down in front of this long machine throwing the levers in the rush hours of night and morning. Another most important reason is that the complicated network of pipes and wires from the cabin to the various switches and signals to be operated would be excessive; the space to be occupied by these pipes and cranks and wires would necessitate several acres in itself and the apparatus would be most difficult to maintain.

In the case of complicated and busy track layouts, it is necessary to move the switches and signals by means of power. Power interlocking plants have come into general use during the last 15 or 20 years for the operation of all layouts that are complicated. In all large terminals, such as the Pennsylvania Terminal and Grand Central Terminals in New York, the Washington Terminal, the St. Louis Terminal, and the Broad Street Station, at Philadelphia, the switches and signals are operated by power.

Power interlocking does not differ in the protection it affords, or in the general principles involved, from the smaller and mechanically operated interlocking plants. Power interlocking systems have the advantage of being free from hand labor. The movement of a switch is accomplished by some kind of motor mechanism situated close to the switch point. The towerman moves a small, easily operated little crank, but it is not the strength of his arm which operates the signal or the switch. The small crank in the tower moves an electric circuit closing device which permits the flow of electricity along the wires leading from the tower to the motor device at switch or signal. The wires are laid all together in cable form placed in a wooden conduit along the right-of-way, and wires branch out from the cable opposite the switch or signal to be operated. In this way the pipes, cranks, large levers and wires of the mechanical system are eliminated.

The power interlocking machine occupies compara-

tively little space on account of the smallness of the levers and the compactness of the parts. The levers are just large enough to permit a man to grasp them. As an example, one may mention the electro-pneumatic interlocking installation at the St. Louis Terminal. The layout consists of 44 double slip switches, with moveable point frogs, 65 single switches and 145 signals. The machine itself has 215 levers, but the machine is only 44 ft. long. As many as 33 levers are not in use, having been provided for future extensions.

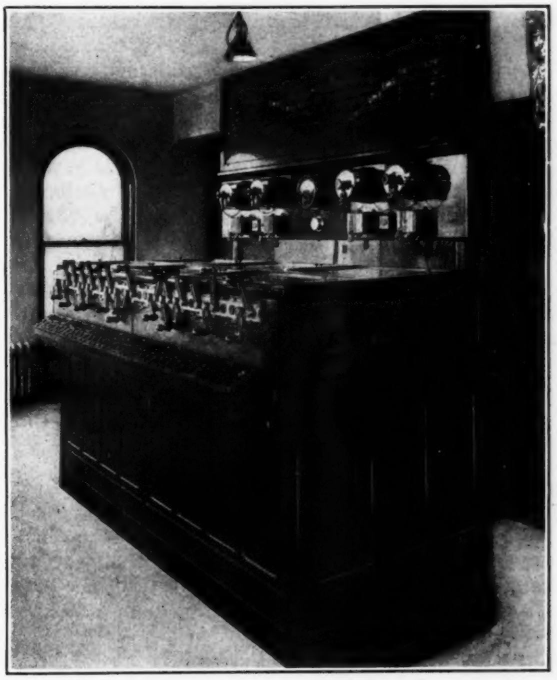
If a mechanical interlocking machine had been used to do the work of this power machine, it would have required 528 levers, and would have been 245 ft. long. If 55 ft. were further required at this machine, one may imagine the "100-yard dash" a towerman would have to make in order to throw two levers at opposite ends of the machine. Generally speaking, a power plant requires one or two men to operate it, while a mechanical interlocking machine to do the same work would require six or seven men.

Power-operated switches are quicker in action than mechanical operated switches. The power switch throws the movement over very rapidly, which is a matter of considerable importance in a busy terminal where trains are being run back and forth in great numbers. Summarizing, the four principal advantages of power interlocking over mechanical plants we find that they are: first, economy in cabin space; second, they require a less number of men to operate them; third, the movements are quicker in their operation; and fourth, power interlocking is the only thing possible where a complicated layout is concerned.

There are two kinds of power interlockings. The older of the two systems is the Electro-Pneumatic System, which is in service in all the great terminals in this country, with two exceptions, viz: the Grand Central Terminal in New York and the Chicago & Northwestern Terminal in Chicago. All the other great terminals, including Boston South Station, Pennsylvania Terminal in New York, Broad Street Station Terminal in Philadelphia, several large plants in Chicago, St. Louis, Kansas City, and others almost as well known, operate on the Electro-Pneumatic principle.

In the Electro-Pneumatic system, the power used for the direct operation of the switches and signals is compressed air at a pressure varying between 80 and 100 lbs. In the case of switch movements, a cylinder with a 5-in. piston stroke and having a diameter of from 4 to 7 ins., depending on the weight of the switch to be moved, is provided, and is operated by air being admitted to one side or the other, the switch points being actuated by a simple escapement crank driven from the piston. The cylinder is placed directly at the switch points and its piston drives the crank arrangement in such a manner that when air is admitted to one end of the cylinder, it forces the points one way, and when admitted to the other end it forces the points the other way. Thus, the actual power for moving the switch is compressed air.

The admission of the air to the cylinder is controlled by an electric valve. This electric valve is simply an electro-magnet whose armature controls a pin valve allowing the air to pass from the main air line to the cylinder. It is, of course, understood that the interlocking plant is provided with one large air main from 2½ to 3 ins. in diameter, extending from one end of the plant to the other, and provided with small branches to each point to be operated. The admission of the air from the main line to the switch cylinder is controlled by the electric valves. Electric current for the control of the valve is secured by the interlocking lever in the cabin. In other words, when the towerman moves a lever, he closes a circuit which energizes an electro-magnet at the appropriate switch, no matter how far away. He can throw the switch either way he desires because a valve magnet is situated at either end of the cylinder. The movement of the signal blades is similar in principle. An air cylinder governs the movement, and the flow of air to one end of the signal cylinder is electrically governed in the same way the switches are. Each signal is operated by one electro-magnet, and to clear the signal the towerman moves his lever to the corresponding position and this causes air to rush into one end of the cylinder and effect the movement of the signal blade. When the signal is to be put in the stop position, it is only necessary to cut off the electric current and the signal "falls" to stop by gravity, the semaphore being counterweighted for that purpose. If a wire breaks, the electro-magnet is de-energiezd, air is cut off from the cylinder and the signal falls to stop by gravity. If the air fails, or the electric current ceases to flow, the signal falls to stop by gravity, and all such failures are on the side of safety. The electro-pneumatic system was invented by George Westinghouse about 1880.



Typical Installation in Signal Tower

In the purely Electric Interlocking System the movements of switches and signals are accomplished by an electric motor, placed directly at the switch or at the signal. The power for the operation of this motor is carried over wires from the contact on the interlocking machine lever to the motor to be operated. The interlocking machine used in the Electric system is practically the same as that in the Electro-Pneumatic. The lever has simply to be large enough to carry the contacts which close the various circuits. All the power for the motors is controlled directly by lever contacts. In order not to waste too much power through heat losses in the wire which is laid between the lever and the motor, the voltage on these wires has to be made commensurate.

The electric interlocking system, besides the electric motor, requires certain circuit controllers. The elec-

tric motor operates at considerable speed, so the switch operating crank has to be driven through a system of gear such as is used in an automobile transmission. Therefore, the electric system, while somewhat more economical than the Electro-Pneumatic system, is more difficult to maintain. It involves motors, gears, circuit controllers, etc., requiring the attention of a man who is familiar with both electrical and mechanical appliances.

However, the electric system has an important advantage for small interlocking plants. In the Electro-Pneumatic system, a supply of compressed air must be available. In the case of an isolated interlocking which is too large for a mechanical interlocking plant, it may not be advisable to put in an Electro-Pneumatic system, on account of the apparatus required for compressing air. In such a situation an electric plant will be the cheaper. In an important terminal an air compressor is usually provided for car cleaning, and this may be utilized to furnish air to operate the signals and switches. Mechanical systems are suitable for unimportant layouts involving only a few switches, and where train movements are relatively infrequent. Power interlockings are generally used at all congested points where there are frequent train movements. Power interlocking plants are divided into two classes, viz: the Electro-Pneumatic system which compressed air moves the switches and signals. This compressed air is governed by magnets controlled from the tower. The other system is the Electric Interlocking System, where the devices are actuated entirely by electric motors.

Waterproofing Concrete Roof of Pier

By J. B. GARDINER

Ass. Mem. Soc. C. E., Secretary Minwax Co.

The waterproofing of concrete for building and roofing operations has assumed such an importance in recent years that it can safely be assumed that where an unusually difficult problem has been solved, the methods and reasons for their adoption will be of service in making plans for new work.

The roof of the Recreation Pier at the foot of Broadway, Baltimore, was designed in its main elements, similar to those of the solid floor deck girder of railroad bridges—not only to sustain the dead load incident to general roof construction, but the live load of hundreds of children running over it. There are two longitudinal girders running the full length of the roof, supported at suitable intervals by channel columns. These girders in turn carry a series of I-beams, one every forty feet, running transversely. On these I-beams is a 1-2-4 reinforced concrete slab 5 ins. thick. In order to get proper drainage, both to the sides and to the free end of the pier, a layer of cinder concrete was placed on the slab, tapering from an inch on the sides to 5 ins. in the center. The entire deck is surrounded by an iron railing, supported on posts resting on base plates and fastened to the deck by means of bolts cast in the concrete slab. The continuity of the concrete surface is further broken by eighteen metal columns supporting electric lights, and by one hundred and twenty metal sockets, regularly spaced and protruding 6 ins. above the surface, designed to receive the standards for an awning which is used in hot weather. The two sides and one end of the roof, which is 304 ft. long by 135 ft. wide, are free, while the other end abuts against a building. There were no expansion joints provided, either longitudinal or transverse.

These are the main structural elements of the roof as it was when it was first turned over to the waterproofing company for waterproofing. The original specification called for an asphalt mastic, an inch to $1\frac{1}{2}$ ins. in thickness, and the usual construction and maintenance bond was required of the contractor.

After a few months cracks began to develop in the mastic sheet, and in a short time it was literally check-

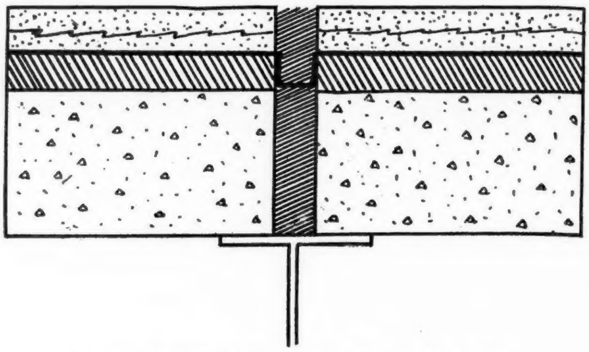


Fig. 1. Detail of Transverse Expansion Joints

ered with small openings running in all directions. Naturally, leaks developed wherever the cracks appeared, the water dripping through on to the merchandise beneath, and also running over and corroding the steel frame work. Attempts were made to repair the waterproofing by filling the cracks with asphalt, but no sooner were the existing cracks closed than new ones developed. It may be said in passing that this was not surprising, bcause it has been found that an asphalt mastic covering alone has seldom proved to be a satisfactory method of waterproofing. Shrinkage or temperature cracks almost always occur. Particularly is this the case where the area is large and the sheet continuous. The writer had occasion a short time ago to inspect some new concrete bridges on a railroad construction project near New York which had been waterproofed by the membrane method. A protection or armor coat of $1\frac{1}{2}$ ins. thick of mastic had been placed. Although the spans were not more than from 50 to 100 ft., and the width of the mastic sheet was not more than

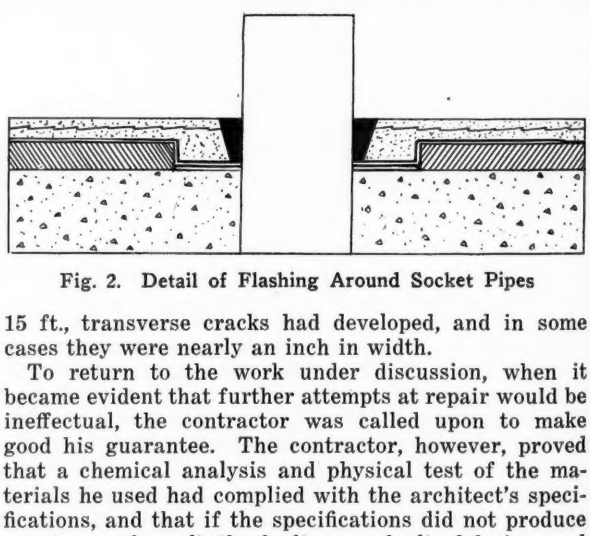


Fig. 2. Detail of Flashing Around Socket Pipes

15 ft., transverse cracks had developed, and in some cases they were nearly an inch in width.

To return to the work under discussion, when it became evident that further attempts at repair would be ineffectual, the contractor was called upon to make good his guarantee. The contractor, however, proved that a chemical analysis and physical test of the materials he used had complied with the architect's specifications, and that if the specifications did not produce a waterproof result, the fault was a fault of design, and not chargeable against the waterproofing contractor.

Aside from the question of the legal responsibility, there is another question of vital importance to engineers using waterproofing materials. The manufacture of waterproofing and its installation are both technical subjects, and must go hand in hand. Every manu-

facturer should know what conditions his material will have to meet and what it will not have to meet. It will reflect little glory on the reputation of a manufacturer who proves that the material he furnishes meets imperfect specifications, unless he can also prove that he made an attempt to have the specifications revised to a basis where fulfilling them would have given satisfaction.

It was necessary to have the roof waterproof, and it was decided to have the entire work done over again, and bids were taken. The new plans and specifications were in a measure tentative, and the various bidders were privileged to submit revised plans of their own, and to bid on the use of materials adapted either to their plans or to the plans drawn by the architect. After a hearing, at which each of the bidders was given every opportunity to discuss his methods and his materials, the contract was awarded on the following specification for materials, although the bid was over $3,000 higher than the lowest bid on the same plans.

The specification was as follows:

"The waterproofing course was to consist of two layers or plies of saturated cotton fabric, laid in and cemented with an asphaltic bitumen. The materials were to fulfill the following specification:

"The cloth to be a woven fabric of diagonal weave, to give it maximum elasticity; to be delivered on the work thoroughly impregnated with an asphaltic bitumen, entirely by pressure and without the use of oils, petroleum residues or bitumen solvents to liquefy the bitumen in order to produce this saturation. No wood pulp, talc or other substance which will prevent close permanent adhesion between successive plies shall be used on this cloth. The cloth shall be elastic, stretching at least 10 per cent in any direction without fracture, and shall be of the following strength:

"A one-inch strip, when tested by a Kompagraf or other standard machine, shall show a tensile strength of at least 100 lbs. to the inch. The cloth must be proof against puncture to the extent of 90 lbs. to the inch, when tested by a standard paper testing machine. It shall be thoroughly flexible, so as to conform readily to the surface to which it is applied, and to permit of close snug flashing.

"The bitumen with which this cloth is applied shall be a tough naturally occurring asphaltic bitumen, having a melting point between 175 and 200 deg. F. It shall have a penetration of at least 30 centimeters when tested with a No. 2 cambric needle at 77 deg. F., and the penetration shall not be reduced more than 20 per cent by heating for seven hours at 325 deg. F. The loss in weight, after heating for seven hours at 325 deg. F. shall not be greater than one-half of one per cent. The bitumen shall be flexible and ductile between 15 and 130 deg. F., and shall form a close mechanical bond not only to the membrane and the concrete to which it is applied, but also to the concrete which is cast against it."

The details of the waterproofing involved some very interesting and unusual features. First, it was deemed advisable, because of the length of the structure, to provide expansion joints. Accordingly, seven transverse joints were cut through both the mastic and the concrete, clear through the slab to the steel, the joints coming over the center line of the flange of the I-beams. Although the deck is 134 ft. wide, it was not deemed necessary to cut any longitudinal joints through the concrete, as both sides were unobstructed, and the concrete could, without danger, expand indefinitely. To prevent the mastic cover from moving, joints were cut through the mastic, but only to the concrete. All joints were one inch in width, and were cut with a compressed air tool. The principal features of the waterproofing are the waterproofing of the expansion joints, the flashing around the awning pole sockets and the flashing along the line of juncture of the building and the pier.

In Fig. 1 are shown the details of the method used in waterproofing the expansion joints. The transverse joints, from the steel beams to the top of the concrete, were first filled with an expansion joint cement. The waterproofing, consisting of two plies of saturated fabric, which conformed with the specification and was laid in and cemented with an asphaltic wax. It was carried down into the joint as shown, so that should further contraction occur than that provided for by the width of the joint, the waterproofing course would be subjected to no tensile strain. The remaining portion of the "U," thus formed, was then filled with an expansion joint cement.

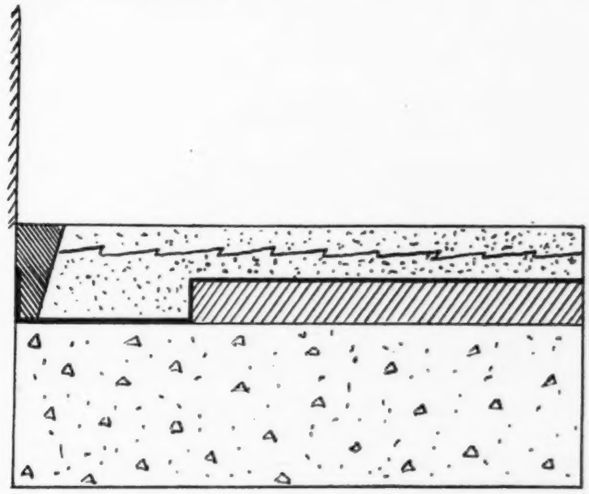


Fig. 3. Detail of Flashing Against Building

The method used in flashing around the sockets is shown in Fig. 2. The mastic was cut away 3 in. around each socket. One layer of cloth was then carried over the mastic, and down over the surface of the concrete that had been exposed by cutting away the mastic. An iron washer with a 3-in. flange was then slipped over the socket, the waterproofing course proper, consisting of the two-ply blanket, was laid over the one-ply previously put down, over the washer and up to the socket. In casting the wearing surface a circular wedged-shaped form was placed around the socket, and the space left after this form was drawn, was filled with expansion joint cement. This class of material was selected because of its great adhesive and elastic qualities.

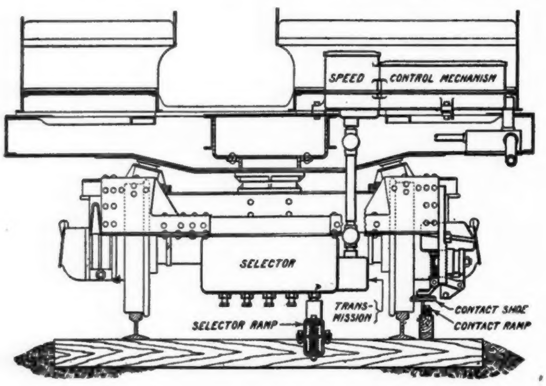
Illustration Fig. 3 is the method used in flashing against the base of the building. As a means of flashing, where the railing posts rested on the concrete, the base plates were unbolted and raised, and the waterproofing slipped under them. They were then bolted back in place. This formed a very secure joint.

The wearing surface was 1½ to 1 cement mortar, reinforced with poultry netting, trowelled to a sidewalk finish, and tooled to give a good foothold. It was cast in 10-ft. squares, a joint of ½ in. being left between abutting edges of successive squares. This joint was filled with an expansion joint cement. The entire wearing surface was then given two thorough coats of a concrete hardener to prevent dusting of the cement. Complete cost data has not been compiled, but will soon be available for those who are interested.

Principles and Operation of Speed Control Mechanism

Automatic Brake Application If Stop Indication is Overrun. Speed [Controlled If Motorman Ignores Caution Signal. Auxiliary Indications Given. Overlap Not Necessary

A speed control and signal system has been developed in which a cab signal may, at the discretion of the using company, be made the sole indication for the motorman on electrified lines, or if desired, the fixed automatic signal by the side of the track, may be used; but in any case the cab signal is an essential part of the apparatus. It does away with the outside stop arrangement operated by a trip or other device, and for this it substitutes a short ramp placed between the rails, and this ramp is electrically energized from the track circuit or is de-energized by the presence of a



End View of Car with Contact Ramp

train in the block. Interlocking fixed signals are of course used.

The cab signal is so designed as to give information as to when to apply brakes, also when to resume normal speed, also the permissible speed, and practically to indicate the available braking distance. Each car is equipped with a speed-control, which automatically applies the brakes if the motorman fails to obey the cab signal. The system is arranged to compel a stop at fixed interlocking signals by automatically applying the emergency brakes if a train should attempt to go on, when the signal shows "stop."

Cab signals are placed at both ends of each motor car and indications are given by two lights. A green light indicating "proceed" if the two blocks next ahead are clear; and a yellow light shows "caution" when the next block ahead is clear and the second block ahead is occupied or is governed by an interlocked signal at "stop."

The audible signal in the cab is so connected with the speed-control mechanism, that it sounds earlier than the automatic speed-control application of the brakes takes place and permits the motorman to slow down sufficiently to avoid the application of the brakes. An indication is given in the cab to show the maximum allowable speed and the distance within which, after a caution signal has been met and passed, the speed of the train must be reduced to avoid the automatic application of the brakes.

The speed-control mechanism is so arranged to act, that when a train runs into an unsignaled section a distinctive indication is given in the cab, and the cab signals and speed-control equipment are automatically put out of service. They automatically return to service again when the train enters a signal section.

The speed-control equipment does not interfere with the operation of the train so long as the motorman runs according to the cab signal indications, but if he fails to obey the "caution" signal shown in the cab right in front of him, the apparatus enforces compliance by applying the brake, but only if the speed exceeds that which is prescribed.

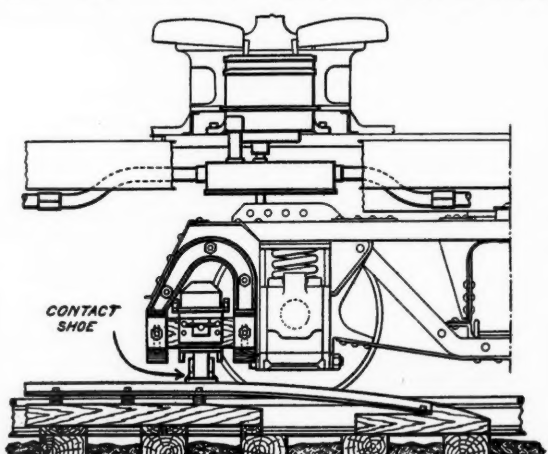
When a train, moving at a speed below the prescribed minimum, approaches a clear block, its speed-control apparatus is, previously, automatically reset so as to permit the train to accelerate. If a clear block is succeeded by one with a train in it the following train may accelerate, slowing down if the speed thus acquired exceeds that established by physical conditions. If a clear block is succeeded by another clear block, the train is permitted to run at normal speed.

In the event of the failure of the speed-control mechanism it may be cut out of service, but this does not interfere with the operation of the apparatus on the remaining cars of the train.

The speed-control and cab-signal equipment is actuated by means of ramps adjacent to the tracks so as to insure full track capacity and facility of operation.

The cab signals are practically block signals and indicate the condition of the blocks ahead. At crossings, junction-points, terminals, etc., fixed signals of the light type are used to show the route set up. The indications of interlocking signals are given by one light, green for the high speed route, yellow for the diverging route, and red for stop.

The operation of the speed-control mechanism depends on a governor. A bevel gear attached to the axle carries motion from the revolving axle and gives it to a worm. This worm is constantly in motion as the car



Side View of Car with Contact Shoe on Ramp

moves and its speed of revolution varies with that of the car. By means of a magnet de-energized, this worm, jointed appropriately, is permitted to fall by gravity and mesh with a toothed sector, or it is drawn up and away from the sector when the magnet becomes energized. The action of this magnet, and the glowing of the cab signals is controlled from the ramp, which is energized or not, according to whether a block is empty or occupied.

The energized ramp holds the signals and the control mechanism normal. But when the ramp is de-energized by the presence of a train in the block, an appropriate signal glows brightly before the motorman's eyes, and the worm drops into the toothed sector and begins to move it, so that in a predetermined time it will set the brakes. When the worm begins to act, a caution signal glows, and the motorman may then, if he obey it, apply the brakes and slow down. If he fails to do this the time interval, always consistent with safety, elapses, and an automatic brake action follows:

If, however, the motorman at once applies the brake, he consequently reduces the speed of the train, the wheels turn less fast and the action of the worm on the toothed sector becomes slower, and the time interval is necessarily lengthened as the train comes to the required pace. At the next ramp, if the block is clear, the ramp is energized and by acting on the magnet, lifts the worm away from the toothed sector and things become normal again. The action of the ramp puts the automatic brake-applying apparatus to work at once, but the worm and toothed sector, (which latter in its final position applies the brakes) is like the delay-action fuse on a high-power projectile which holds back the explosion until the shell has buried itself in the object of attack.

The selector and selector ramp placed between the rails are used for giving more detailed information in the form of a displayed word, such as when to apply brakes, when to resume speed, permissible speed, available braking distance and such other information as may be deemed necessary to properly control the train speed. Such information is given independently of the speed-control mechanism and the position of the selector ramps on any railway is governed by experience or the physical configuration of the road.

The automatic application of the brakes takes place at varying distances from the end of the block, depending upon the speed on account of the toothed sector being moved quickly or slowly by the worm connected to the axle, and this fast or slow action of the sector depends on train speed. This is one of the strong points of the system. The usual system with automatic stops has an overlap, the length of which is based on maximum speed. Failure to obey a stop indication would cause an emergency application at the same spot for any train, regardless of speed. This requires that trains be kept apart a distance equal to the length of the overlap, which is usually a full block. With the speed-control system, trains can close up, provided the speed has been reduced. In the speed-control system this important facility is provided by the fact that trains can close up instead of being spaced a full block apart. They thus may come nearer each other slowly and under control.

The system is handled by the General Railway Signal Company of Rochester, N. Y., under the Simmens patents for speed control. This equipment is used on the cars of the New York Municipal Corporation.

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Contract for Steel Bridge in Canada

The contract for building the superstructure of the railway bridge over Smoky River, Alberta, for the Dominion, Dunvegan & British Columbia Railway has been awarded to the Dominion Bridge Co., Ltd. The material will be fabricated in this company's Winnipeg establishment. The bridge will consist of two 86-ft. deck plate girder approach spans, six 120-ft. deck spans, and one 125-ft. through truss span which will cross the main channel of the river, the steel in the superstructure will probably weigh nearly 1,200 tons.

Principles of Dynamo-Electric Machinery

By REGINALD GORDON

Induction, Magnetic Field, and Electro Motive Force Defined and Simple Demonstrations Illustrated

In order to clearly understand the action of a dynamo or electric generator, and its counterpart an electric motor, the following experiments with simple apparatus will serve to make the matter plain. In the first illustration, Fig. 1, a coil of wire having an iron core is shown connected with an indicator or galvanometer. The latter is a coil of many turns of fine wire, at the centre of which is a magnetic needle, whose motions

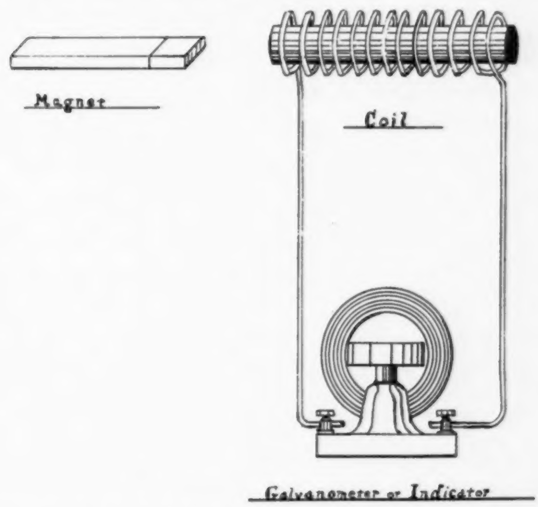

Fig. 1. Indicator Showing Development of an Electric Current by Movement of Magnet

show the direction and strength of the magnetic field produced by a current in the coil. There is no battery in this circuit, yet when the large magnet shown is brought near or moved away from the end of the coil,

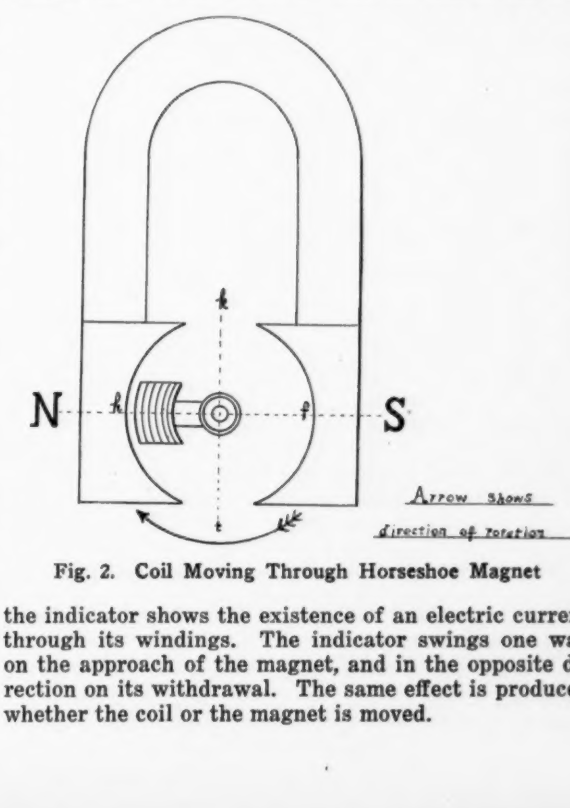

Fig. 2. Coil Moving Through Horseshoe Magnet

the indicator shows the existence of an electric current through its windings. The indicator swings one way on the approach of the magnet, and in the opposite direction on its withdrawal. The same effect is produced whether the coil or the magnet is moved.

In the next diagram, Fig. 2, the same principle is shown by representing a coil of wire rotated in the field produced by the two poles of a magnet similar to those of the common type of magneto-generator.

Before going any farther, however, it is necessary to remind the reader that in speaking of energy, whether in large or small amounts, one must distinguish between quantity and pressure. The amount of power developed by a water wheel, for instance, is known definitely only when the number of gallons per minute and the height through which the water falls are known. So with electric energy, the quantity is expressed by the unit Ampere and the height or head or pressure or electromotive force is designated by the unit called the Volt. These are distinctly different ideas or concepts and unless clearly registered in mind may lead to confusion.

Referring again to the second diagram, the coil is shown in the magnetic field in front of the pole N. When the coil is rotated in the direction shown by the arrow, an electro-motive force (abbreviated e.m.f.) is at once set up in it, which decreases in intensity until it is zero when it reaches the position indicated by k, midway between the two poles. As soon as the coil passes the point k, this e.m.f. begins again and becomes stronger in the same sense, as the coil moves around until the latter reaches the point f, where it is a maximum and where it suddenly reverses, decreasing to zero as it moves from f to t and again increasing in the same sense in approaching the pole N at h. In other words, a conductor rotated through a bi-polar field such as that shown in Fig. 2, has a current of electricity generated in it that is reversed in direction twice during each revolution. This is usually shown by the conventional diagram of the third illustration, Fig. 3, where the height of the curve above or below the line N S represents the values of the voltage developed at any point during one rotation of the coil from t to t.

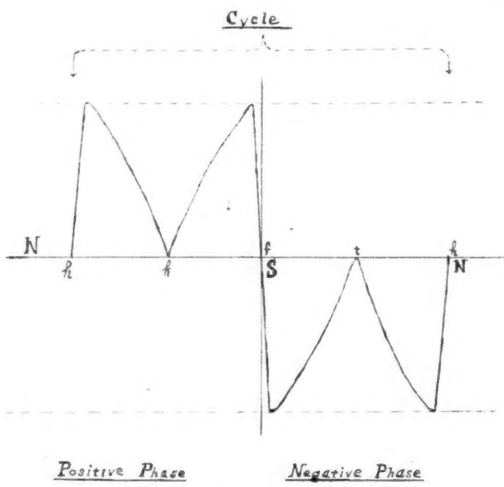

Fig. 3.—Curve Showing Intensity and Direction of Electro-Motive Force

The points h and f of the curve indicate the two points of reversal of the e.m.f. in front of the two poles respectively. The point k indicates the zero value of the e.m.f. on passing beyond the influence of pole N and coming nearer the pole S, and the dropping of the curve below the line NS indicates a change in the direction or sense of the e.m.f., but shows its development in the same manner with reference to the poles as in the first half of the revolution. Incidentally, this curve will help to explain the distinction between alternating current and direct or continuous current, as the latter is sometimes called. In the last experiment the electric current is in the same sense in passing through one-half of a revolution of the coil and in the opposite sense in passing through the other half. The rotation of the coil in the magnetic field under these conditions gives rise then to a pulsating or alternating current and the sequence of events during one-half of a complete revolution, and shown by the curve above and below the line NS from h to h constitutes what is called one complete "cycle." Each half of this cycle is called a "phase." The electric current generated in the coil during the first half of the revolution is in one phase and pulsating. The next illustration, Fig. 4, shows a single conductor, for the sake of clearness, in a magnetic field arranged to avoid the reversal of the e.m.f. just described. The commutator shown allows the current generated in one part of the conductor when passing the reversing point in front of a pole, to be disconnected from the terminal or brush to which electricity had been passing. A moment later the same part of the conductor is connected to the other brush, thus sending current in the opposite sense into the external circuit. This arrangement furnishes a pulsating current, but direct in the sense of not suffering reversal. Generators are built with a large number of conducting coils on the armature or rotor so as to give as many impulses as possible for each revolution. In all that has been said, the field has been produced by a permanent magnet, constituting a magneto-electric generator. A dynamo-electric generator is so constructed that the current developed in the armature is wholly or in part utilized to create the magnetic field.

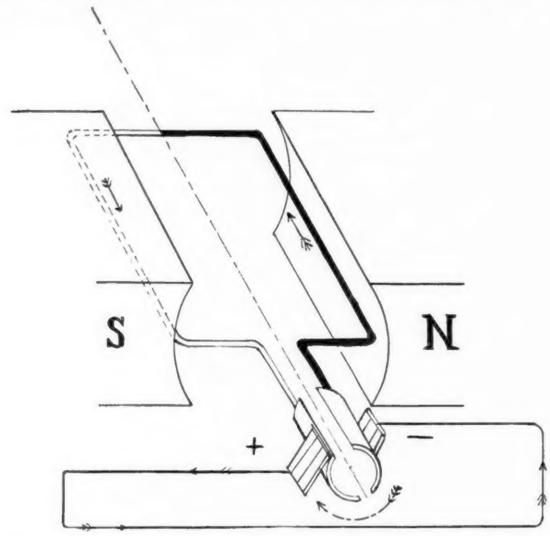

Fig. 4.—Commutator Attached to Rotating Conductor, Generating Direct Current

The Buffalo Chamber of Commerce gave a luncheon recently in honor of the completion of the first part of its terminal facilities. For more than 25 years Buffalo has been troubled with the terminal problem. In the last few years the Terminal Commission has had the matter in hand with the work of the Chamber of Commerce and the city administration, and definite results have now been accomplished. The first to be completed is the freight terminals of the Lehigh Valley R. R., including an office building and a freight shed 600 ft. long, with extensive yards, team tracks, etc.

Efficiency and Standardization in Track Maintenance Work

System of Determining the Efficiency of Track Gangs. Standardization of Methods in Maintenance Work. Bonus to Track Gangs Above Minimum of Efficiency.

A problem in efficiency, and also in the standardization of work, in which something like the Taylor theory of efficiency is involved, was explained by Mr. S. L. Conner to the members of the New England Railroad Club at a recent meeting. Mr. Conner, although a professor of railroad engineering at Tufts College, Boston, yet as a special piece of work performed the duties of assistant supervisor on the B. & O. Railroad. He expressed wonder that the principles he saw exemplified there were not more generally adopted in railroad work.

He spoke first of the labor problem. Track men are recruited from the least intelligent class, and are men who usually cannot gain employment in other fields. It has become common practice to hire these men through labor agencies and by so doing securing an undesirable class at wages ranging from $1.25 to $1.75 per day. All of us are aware of the responsible character of the work done by these men, since the lives of millions of passengers are annually dependent upon the proper performance of the work, under competent supervision.

All of us expect the full measure of ox-like performance in muscular effort on the part of these men, and some of us realize that a certain degree of mental effort is necessary, even though it may be in the placing of a tie plate, or the renewing of a rail joint. The men work industriously, and it is a singular thing that passing strangers hold little of interest to the man occupied with his work.

At the outset it is proper to indicate that this method of track work efficiency has for its basic idea an incentive to the man, in the shape of a premium or bonus, and thus we are dealing with a bonus or premium system. Thus the method affords a stimulus at the very beginning, and an increased performance is secured, and a more uniform result is attained.

There were under this supervisor ten regular or section gangs, three extra work gangs, and one fence gang. The total number of men employed daily was between 150 and 200 men.

It is obvious that under such a system as this the supervisor must be always on the alert, and be in constant touch with the whole of his sub-division, and constantly patrolling it. The work of planning constitutes a considerable part of his time. It was the practice of the supervisor to make regular visits. Work orders were used which tabulate all forms of scheduled work, and are, therefore, possible of comparison as regards relative efficiency. There is another kind of work that appears in the maintenance service of all roads, which is called unscheduled work, for lack of a better term. Work that is unscheduled work consists of such items as clearing wrecks, cutting rail for expansion. Items other than those here appearing may be mentioned; patrolling track is clearly "dead" work, since safety precautions cannot be susceptible to measurement; cleaning ashes from passing tracks where freight trains stand is another of these items; cleaning toilets at stations, mowing right-of-way, etc.

An attempt, however, is made to reduce the number of these items to measurable conditions, which until standards can be established, is tentatively accomplished thus, as for example—mowing right of way. This item of work is a variable one, since it may be a full mowing, or it may be an attempt to cut down the high growth only. The latter condition was one that arose this summer, and the writer was informed that the first day's work under observation might be considered as 67 per cent. efficiency, and that any future performance on that particular assignment might be graded above or below this mark as the performance was better or poorer.

The kind of work on the form is all scheduled work, and was as follows: Renewing 36 W. O. ties in E. B. Main in 60 hours' actual performance, and in the outside columns of the form 45 hrs. of standard performance. Replacing 18 ties in E. B. Main in 20 hrs. actual work, and in the outside column 15 hrs. standard performance. Installing 80 tie-plates in E. B. Main in 10 hrs. actual work, which should have been done in 8 hrs. standard performance. Surfacing ties in E. B. Main 20 hrs. actual work, set down as 15 hrs. standard performance.

In order to understand how the standard performance is determined, the first item was that of renewing 36 W. O. ties, and is considered for that condition where the tie is "in face," or in other words where the track is not raised. Referring to a detailed work sheet, there may be found the detail study of the items involved in this performance. They are the usual motions involved, that of digging the balast from around the old tie, drawing the spikes, removing the old tie, preparing the new bed, carrying the new tie from the pile, placing the new tie in position, spiking it to gauge and tamping it solidly in position, after which, the ballast having been cleared, is returned to the crib, and the old tie removed for burning.

The standard of measurement for 100 per cent. efficiency under these conditions is 8 ties per 10 hours, and since the report called for renewing 36 ties, the actual time for 100 per cent. efficiency is determined by dividing 36 divided by 8 and the result multiplied by 10, thus giving as a result 45 hours. While the tamping involved in this work may be more efficiently done by use of tamping machines, it is interesting to note that these are being considered by this company for use on this work, as has been recently indicated. By referring to one of the late editions of Tratman's Railway Track and Track Work there may be found the statement that the renewing of 8 ties in stone ballast in a day of 10 hours in an average performance for one gang, so there seems to be no injustice done to the man where such a performance is considered 100 per cent. efficiency.

Men work in pairs, each starting at end of crib and digging the ballast out of the cribs adjacent to the tie to facilitate its removal. Spikes are then drawn, the old tie is moved sidewise into open crib and is then removed. A peculiar feature is that here in this operation the men are allowed to drive the picks into face of the tie and are not permitted to do so when putting in new ties. The new bed is prepared and the new tie slipped into place with tongs. One man then holds up the tie close to the rail with a bar, and the other spikes. Each man then thoroughly tamps both sides of each end of the tie outside the rail, and for a distance of 18 ins. inside the rail. After tamping, ballast is thorough-

ly cleaned, returned to the cribs, and the shoulder redressed. Not less than two weeks after renewals, the ties should again be tamped.

An item for respacing bunched ties usually accompanies the work of renewals. The several motions are, digging out the ballast from between the ties, drawing spikes, driving tie to place, spiking to gauge, tamping and finally cleaning the ballast and redressing the shoulder. Respacing 12 ties in 10 hours is considered 100 per cent. efficiency.

As many as 18 ties were respaced in 20 hrs., and it is now easy to determine the standard time by dividing 18 by 12, which gives 15 hrs. as the standard. For respacing ties, cribs are cleaned out, ballast well loosened under ties, spikes drawn or cracked up considerably. On tie to be respaced and the two adjacent ties the rail is raised with bars, tie driven to position with wooden mauls. The use of wooden mauls is along the lines of economy. Their use has resulted from time studies. If the tie to be respaced is next a joint tie or one firmly embedded, good work is often done by moving it with a jack. After ties are respaced they are spiked to the rail, at the same time one man holding the tie close to the rail, and the other spiking. After spiking, each man tamps the tie, one at each end, as in tie renewals, the ballast is cleaned, returned to crib, and the shoulder redressed.

Next comes installing of tie plates and the study of the motions performed. They are, distributing material, spike pulling and adjusting tie, lifting rail and placing tie-plates, driving first and second spikes. In this study the measurement for standard performance is 100 tie-plates in 10 hours. Our report showed that there were 80 tie-plates installed in 10 hours. The measurement for standard performance or 100 per cent. efficiency required only 8 hours.

This study presupposes that the plates have already been distributed by work-train and are either strung out or placed in convenient piles. There is a standard of measurement for handling and distributing the material so that this part of the work has already been measured. The motion study was based on a performance of a gang of ten men and foreman.

The performance of the work in detail is as follows: two men keep about 14 ties ahead of the rest of the gang drawing spikes and adjusting. After these come two men, one holding up the rail with clawbar, using spike as a fulcrum, the other completes the adjusting and slips plate into place. The working foreman in a condition such as this, with his men close at hand, may fill in several gaps at opportune times, and thus increase the efficiency of his gang. Two men now follow up, spiking every other tie to gauge, and are in turn followed by two men who complete the spiking. These last two men keep well in the rear, and not only spike ties left unspiked, but also hammer down all spikes that may need it as result of trains passing over the track during the work. Necessary plates, spikes, and tie-plugs should have been distributed for each tie. A decided advantage in this method, using no jack, is that there is no necessity for men running back and forth for heavy tools, the men are not overburdened, as they have with them only the tools they are continually using. The method here described is where common hook spikes are used.

The next and last piece of work on our daily report was that of surfacing, and the items in its performance of picking up low joints, centers and quarters is as follows: raising low spot with jack, cribbing out the ballast, tamping both ends of tie on the receiving face and on the leaving face, cribs are then filled in and ballast redressed. The standard performance requires that 48 ties shall be surfaced in 10 hrs. as 100 per cent efficiency. It was stated that 72 ties were reported as being surfaced in 20 hrs., and by dividing 72 by 48 we find that the time for standard performance should have been 15 hours as against 20 reported.

In this work, that the grading may be simplified, each end of a tie is considered as a full tie. This was also done to simplify the divisions of the motion study. The method is, previous to surfacing water should be drained from the cribs, rails brought to gauge, spikes tightened. After ballast has been removed from cribs, the low spot in the rail is raised by a jack, the foreman sighting the surface to the desired height. After this the other rail is raised and adjusted by the level board. Men work in pairs, tamping inside and outside of the receiving face of the tie, and also on the leaving face. This is why each end of a tie is counted as one tie. After tamping, the cribs are filled with cleaned ballast and the shoulders are redressed. Ballast screens are used by the B. & O. for cleaning ballast on long stretches. They are the invention of Mr. A. G. Zepp, supervisor on this road.

The scheme is to set up the screens so that a maximum amount may be handled with a minimum of effort. A bag is placed under the screen to catch the falling earth. These bags after being filled are then placed along the outside of the rail or in the center between tracks where they are loaded on cars for shipment to dump. It is claimed that cleaning of ballast has been justified where only one cubic yard of stone can be recovered in a distance of 8.1 lineal feet of double track road. Formerly, in tracks that had deteriorated by presence of dirt and cinders in the voids of the stone, they were restored to condition by a wholesale removal of dirt and ballast, which was a wasteful extravagance, but in the employment of these screens a decided economy, it is claimed, has been effected. Aside from this economical feature, the practice of screening ballast, instead of putting the track up on new ballast, admits of maintaining the surface without disturbing the roadbed under the ties, a vital point in track maintenance. In addition, it is claimed that the screen method is more thorough and is quicker than the other usual ballast fork method, and laborers do not tire so easily.

After the relative values of standard performance have been determined, the record of both the actual time and the standard time is transferable to a sheet called "daily record sheet." One of these is reserved for the performance of each gang, and is filled out in full. Headings are provided for the usual work performed on maintenance work and are gauging, surfacing, etc. Vacant columns show any new schedule work. The column for patrolling track is one of "dead" work, and has no measurement in extra performance. In this column, "general miscellaneous" which is "dead" work, is reported in actual hours, and as it is 67 per cent work, no standard is available. The report shows this time was spent in clearing cinders, pulling weeds, watering, cleaning toilets, etc.

A column is headed "detention," and 10 per cent of the scheduled hours is allowed as detention. For example, if there are 10 hrs. of scheduled work, there is an allowance of one hour for detention.

In the first column is shown the standard scheduled hours and next the actual scheduled hours, which results are obtained by adding up each day's efficiency measurement and the actual hours taken. Next the summation of the total scheduled hours is made. In the total columns of one sheet were 1,751 hrs, of dispatched work and 1,796 hrs. of actual work. By divid-

ing 1,751 by 1,796 we have 98 per cent. The relative efficiency of the gang was 81 per cent, and as 67 per cent (mentioned above) was the limit for a bonus, these men exceeded the average rate of work by 14 per cent.

It is of interest to know how the 67 per cent value was determined as the lowest limit in measuring efficiency. After careful observations by the maintenance officials they agreed that for every $1.50 expended in wages the company should receive $1.00 in return where there was no attempt to bring pressure to bear upon the men for increased output. Thus they determined that the men actually give two-thirds of value.

At the end of the second half of the month a record similar to the one already mentioned is made out and the efficiency value of the several gangs reported to the division engineer. All these records of performances are collected and are set upon a final form. This is known as the monthly efficiency record. The headings on this form are similar to those on the daily record sheet. Upon this form and in the several columns are shown the total performance of each gang on each particular piece of work. From the summation of the figures the relative efficiency of the sub-division as a whole is established and copies of each supervisor's report, together with any comments by the officials, is sent to the several sub-divisions. This affords a contrast and adds a stimulus for better effort on the part of each supervisor. Each division report is in turn contrasted with those of the other divisions on the system, so that each maintenance officer will know how he stands. It is natural that competition is keen, which is a desirable state of affairs, as healthy rivalry always is. While there may be merits and demerits in the whole plan, it is a step in the right direction, and out of its experiences better conditions may, no doubt, be developed.

Construction of Roadbed and Track

Relations of Ties to Ballast and Ballast to Subgrade

The function of roadbed and track is to carry the load which rolls over it. Its capacity to stand the wear and tear which this implies depends very largely on the conditions of the materials in the sub-grades, the kind of ballast and its amount and the size and number of the ties used, and the quality and dimensions of the rail. These in effect were the points first presented to the St. Louis Railway Club by Mr. E. A. Hadley, chief engineer of the Missouri Pacific Railway at a recent meeting of the club.

The entire load, the speaker continued, must be ultimately carried by the sub-grade, and care and study should be given to it, because a great deal of money is spent on track maintenance, which money is wasted because of improper or incomplete work done on the sub-grade at the time of its construction. The sub-grade is usually composed of soil found in the immediate vicinity of the railroad, and most soils are compressible to a greater or less degree.

Two things can be done to make the sub-grade properly sustain the load: First, by increasing its carrying power per square foot. This done by having good drainage, for drainage is most important because the carrying power of dry soil is higher than that of wet. The second thing is to distribute the load from each wheel over as many square feet of sub-grade as possible. This is secured by the ballast, as the greater the depth of the ballast the greater the area over which the pressure is distributed. The closer the ties are spaced in the track, the greater the number to take the pressure from the rail. This result can also be secured by increasing the length and size of ties, and the heavier and stiffer the rail is the greater the number of ties made to support the load from a wheel.

The standard roadbed for a first-class single track is usually considered to be about 20 ft. in width, the edges of the slopes being about 16 ins. below the bottom of the ties and the slope about 1½ to 1. The ballast provides material that can be worked in wet weather and will not be materially softened or otherwise affected by rain, and which will permit the track to be maintained in a practically uniform condition.

When the sub-grade is soft the ballast is continually being forced down into the sub-grade, and the track must be surfaced quite often. The economy of ballast which permits being surfaced quickly and cheaply is increased.

The principal kinds of ballast generally used today are earth, cinders, gravel, chatts, burnt clay, furnace slag and broken stone. Dirt ballast or earth is easily worked in dry weather, but it is difficult to keep up the track with it in wet weather, and it also has a heavy growth of grass and weeds. It is dusty in dry weather and it reduces the life of the ties by decay at the ground line and causes broken ties in the winter by the earth heaving. Gravel is a ballast which increases the life of the tie and makes it possible to maintain good track. It is comparatively free from weeds, especially washed gravel from streams. It is also free fairly from dust. Chatt ballast is the refuse from lead and zinc mines from which the metal has been extracted, and is really finely crushed stone. It almost entirely destroys vegetation, and if not too fine is practically dustless. It is easily worked and gives a neat appearance to the track.

Burnt clay is not used extensively. It pulverizes rapidly and the growth of weeds is heavy. It is usually a rather coarse material and should not be used except where cost of other ballast is high. Granulated slag ballast is molten slag run into water. It forms a fair ballast for yard and side-tracks. The coarse slag is practically crushed rock. It is hard, black and has very sharp projections, which cut into the ties, making renewals difficult, but is free from dust and weeds. Broken stone ballast can be worked the year around and is not easily displaced by running water and is practically dustless It is expensive in first cost and makes tie renewals difficult.

The heavier the traffic the more economical stone ballast becomes, but it is not so for light traffic. On a comparatively solid sub-grade a stone-ballasted track will remain in good condition longer than a gravel-ballasted track. Stone ballast, after being in use for some years, becomes filled with earth from the sub-grade and with cinders and other foreign material, so that it does not properly drain off the water. It must be removed and cleaned with ballast forks to remove the dirt and then replaced with 10 to 20 per cent of new material.

The most common material used for ties is wood, but some consideration has been given other materials, and more consideration must be given in the future. Granite ties were among the earliest substitutes offered, and were used for some time in Ireland and on the old Boston & Lowell Railroad. As late as 1910 these old granite ties were still dug out of the roadbed on the Boston & Lowell. In recent years some concrete ties have been made, and steel ties have been used extensively on the Bessemer & Lake Erie with considerable success. The Pennsylvania Lines have also used some steel ties. The Mexican Railway System, about 360 miles, is practically all laid with steel ties, which seem to have given excel-

lent service. The Pennsylvania Lines have tried concrete ties in stone ballast, but the ties failed under the heavy and high speed traffic and were taken out within three years. The Chicago & Alton and the Pittsburg & Lake Erie have tried concrete ties with only moderate success. The steel ties are more promising, but most of the railroads are using wood. Two things which can be done in this connection, reduce the amount of timber by the use of other materials and, by preserving the wood, decrease the annual renewals. Adopt forestry methods for the forests still standing and cultivate new plantations. The practice of sawing ties from logs should be encouraged as the old idea that a sawed tie is inferior to a hewn tie disappears. To a chemically treated tie it makes no difference whether it has been sawed or hewn.

The general tendency is toward the use of tie plates, and, with the greater use of treated ties it must be extended in order to get full value from the treatment by preventing the rail cutting into the tie. In this country the ordinary nail spike is generally used for fastening the rail to a wooden tie. There are some objections to this, but on account of their comparatively low cost and ease of handling, it is probable that they will continue to be used. The French railways were about the first in Europe to use the screw spike, and it is today universally employed by the large systems on the continent. The use of the screw spike in Great Britain is almost as rare as in the United States.

With the increase in density of traffic there is a tendency of the rail to creep in the direction of traffic, and on account of the joint ties being spiked through the slotted holes these ties move with the rail and cause bunching and rough track. To overcome creeping there have been numerous appliances devised for anchoring the rails to the ties. They are generally fastened to the base of the rail and bear against the side of the tie. The first rails used, both in this country and in Europe, were made of iron, and an iron rail, even when manufactured in the best manner, was little more than a bundle of rods. Under the heavy pounding of the locomotive the top of these rails had a tendency to spread sideways and become laminated. It is significant that during the twenty years preceding 1868 the price of iron rails had been gradually reduced to one-third of their original cost. The reduction in price accompanied an inferior quality of iron. In Europe and in England the use of steel rails was begun about 1861, and in the United States about 1864, when the Chicago & Northwestern, the Philadelphia, Wilmington & Baltimore, and the Old Colony & Newport each laid portions of track with this metal supplied from Europe. The first Bessemer steel rails made in America were rolled at the North Chicago Rolling Mill on May 24, 1865. The first steel rails rolled in the United States upon order were made at the Cambria Iron Co., Johnstown, Pa., August, 1867.

The adoption of an improved section was very slow, and as late as 1881 there were 119 patterns of steel rails of 27 different weights per yard and 180 older patterns in use, or a total of about 300 patterns. In 1893 the American Society of Civil Engineers brought out designs of rail sections, which were adopted and used by many railroads, so that in a few years about two-thirds of the output of the rail mills conformed to these designs.

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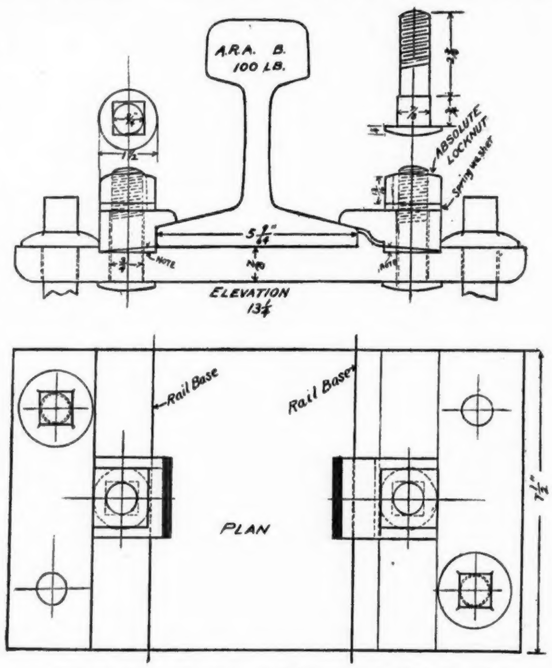
Much of our reasoning is performed in order to justify our feelings, or to find proofs for the position dictated by our desires, feelings, sympathies, prejudices or sentiments. It has been said that men seek not reasons but excuses for their actions.—W. W. Atkinson.

Rail and Tie Fastenings

Editor Railway Engineering and Maintenance of Way.

Sir—In your January, 1916, issue, on page 19, there is a brief mention made of a discussion which took place at the St. Louis Railway Club on the question of rail and tie fastenings. From a mechanical point of view there can be no doubt as to the desirability of fastening the rail to the tie-plate in such a manner that it interferes as little as possible with the fastening of the tie-plate to the tie.

As a matter of fact neither screw spikes nor drive spikes can be expected to accomplish all that is desired of them when certain loads are carried by the rail. The reason for this is that the stresses in the wood of the tie itself exceed the elastic limit for that material. The pulling action due to the wave motion of the rail is largely responsible for this, and naturally can never be eliminated. The number of repetitions of the load



The LaBach Design of Tie-plate and Fastening

and the amount they exceed elastic working conditions will be the governing factors in length of service. There is also a pulling on inside spikes due to the overturning tendency of the rail itself.

If the fastenings are separated the overturning effect will be lessened in much the same manner as if the rail base had been increased in width.

By the use of clips to fasten the rail to the tie-plate a small space may be left for the vertical working of the rail. Spring clips may also be used on spring washers as shown in drawing attached.

It must be borne in mind, however, that when rails are secured in this manner precautions must be taken against creeping.

A couple of years ago the writer attempted to design a tie-plate which could be rolled; the accompanying print shows the result. It is a shoulder plate to vary in thickness between ½ in. and ⅞ in.

It would be interesting to secure a discussion of the problem and some completed designs showing how the problem had been solved in different cases.

Paul M. LaBach,
Chicago, Ill. Asst. Engineer, C. R. I. & P.

Limiting Individual Judgment

Editor Railway Engineering and Maintenance of Way:

Sir—An editorial in a recent railway journal inspires me to give you my opinion on a few items of our maintenance of way work, which I claim should be standardized. It is generally conceded that in unity is strength, and standardization to me spells the same.

First, we should have a standard templet or guage, similar to that used by mechanical departments on wheel flanges, to test ball on rails to determine just when a rail is worn sufficiently to be removed from track.

Tie standards should be for new work, unload and pile 30 ties at every tenth joint or every second pole; for renewals, 3 ties for every 33 ft. rail each year in fine ballast, or 10 ties per rail every four years for stone ballast, on account of the destruction to the ballast bed by renewing a few ties under a rail each year.

Worn down frog wings should receive the same consideration that hollow worn driving wheels get, that is, remove them from track when worn down ⅜ of an inch.

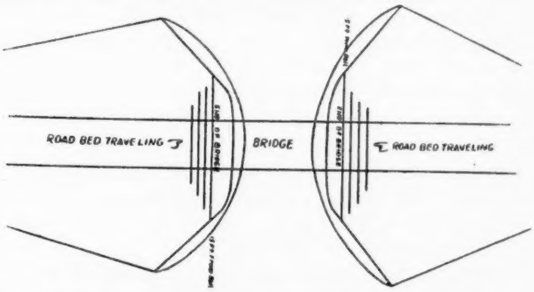
Last but not least a standard pay for maintenance of way employes in the United States and Canada would eliminate the very great amount of friction that exists on account of the irregularity of wages paid for similar service; and, when the conditions justify an increase of pay on the railways of the country, there would then be a standard by which to proportion the increase according to service. Yours truly,

J. HEALY,
Supervisor Hocking Valley Railway, Logan, Ohio.

Handling Bridge Approach Embankments

Editor Railway Engineering and Maintenance of Way:

Sir—Several years ago the writer had considerable trouble by a roadbed moving and pushing bulkhead boards forward at the approaches of a bridge. The strain was so strong that it broke some of the bulkhead boards. Being on a down grade of about 1½ per cent, I could see only one remedy, and that was to release all the bulkhead boards from the bottom up, as far as where the cap rests on the piling.



Arrangement of Bridge Approach Embankments

After bulkhead boards were released, I increased the width of the embankment at the approach of bridge to 15 ft. from the rail, filled in with earth from the edge of the embankment, clean around underneath of bridge extending 5 ft. ahead of the bridge, as high up as where the cap rests on the piling and thus allowed the roadbed its freedom to move and adjust itself, and I had no more trouble after that. The upper four bulkhead boards remained in their proper position.

If railway companies would increase the width of embankments at the approaches of bridges to 15 ft., the approaches of the bridges would keep better surface, and if the companies would discontinue putting bulkhead boards down to bottom of embankment, it would be an improvement. As stated in this letter, there would be less trouble of maintenance on both bridge and track, and besides a saving would be affected by using less lumber. I cannot see the necessity for using more than from 3 to 4 upper bulkhead boards.

You will find enclosed diagram shows the proper position of the embankment, properly widened out at the approach of the bridge. Kindly let the letter appear in print in your Railway Engineering, as this theory or idea may be, and likely is, of interest to many of your readers.

HENRY KOCH,
Section Foreman,
Las Tanos, New Mex. El Paso & SouthWestern Ry.

Book Reviews

The Mechanical World—Pocket Dairy and Year Book for 1916. This is the twenty-ninth year of its publication. Emmott & Co., Manchester and London, England; The Norman Remington Co., Baltimore, U. S. A., and the Marnzea Kabushhiki-Kaisha, Japan. Price, 30 cents, postpaid.

It is a collection of useful Engineering Notes, Rules, Tables and Data. It is truly a pocket diary readily carried so as to be consulted at any time most conveniently. It is virtually all the "world of mechanics," snugged up for quick and oft needed information.

Conversion Chart and the W-PVT Chart, by Merl Wolfard, S. B. and M. M. E., and Charles K. Carpenter, M. E. John Willey & Sons, Inc., New York.

The Conversion Chart, 12 in. by 34 in., represents more than 40 complete conversion tables, including power, speed, linear, surface and volumetric conversions by means of a novel of logarithmic co-ordinate paper.

The W-PVT Chart, 24 by 38 ins., is divided into two quadrants by use of a heavy diagonal line bringing the PV quadrants close to the TV quadrant, so that pressure temperature and volume relations throughout any gas engine or air compressor cycle may be easily determined. The chart may be entered directly in any units of pressure, temperature or volume, and cube or cube root and the 3/2 or 5/2 power or root of any number may be obtained.

The chart is printed on accurately divided logarithmic co-ordinate paper and all plotted scales are open enough to insure a high degree of accuracy.

Resuscitation from Electric Shock, Drowning and Asphyxiation. By Charles A. Lauffer, A.M., M.D. Published by John Wiley & Sons, Inc., New York, 1915. Price 50 cents.

This book is one of ninety pages, illustrated, bound in cloth, and is pocket size, 4x6½ ins. It deals in a scientific, yet easily understood style, with causes, the physical effects of this class of accident, which temporarily suspends animation, and in which prompt and intelligent aid must be given without loss of time. There is always danger from such accidents on railways, and no man who comes in contact with his fellowmen in this modern day should be without a knowledge of an effective method of resuscitation which he is liable to need at any moment.

The book not only gives full and practical information as to what to do and how to do it, but also what not to do, which is frequently just as important. It is written in concise language and is therefore short and to the point, and the methods explained here have been the means of saving human life.

In this new edition forty-two pages have been added dealing with chemical manifestations of illuminating gas poisoning, commercial devices for artificial respiration, resuscitation by means of the prone pressure method, with examples of its success, and by means of artificial respiration. The full contents follows:

Instruction in Resuscitation. Forethought. Successful Results. Types of Cases Requiring Resuscitation. Mechanism of Respiration. The Method. I. Position of Patient. II. Posture of Operator. III. Mode of Operation. IV. Rate Per Minute and Duration of Operation. Supplemental Assistance. Mechanical Resuscitation. Prof. Schaefer on the Prone Pressure Method. Clinical Manifestations of Illuminating Gas Poisoning. Commercial Devices for Artificial Respiration. Resuscitation by Means of the Prone Pressure Method. Resuscitation from Electric Shock. Drowning and Asphyxiation by Means of Artificial Respiration. Successes of the Prone Pressure Method. Hero Medal Recommended.

Maintenance of Way and Structures. By William C. Willard, C.E., M.S. Published by McGraw-Hill Book Co., Inc., 239 West 39th St., New York, and 6 Bouverie St., London. Price, $4.00.

There is very little if anything on the subject of maintenance of way and structures which this work does not fully consider. The matter is arranged and treated in an interesting and instructive way and is something which the practical engineer as well as the student will enjoy and profit by. Altogether it is an up-to-date discussion of all the problems and matters which confront the construction department of a railroad and that all important maintenance of way department. The roadway, fastenings, tieplates, signs, fences, highway crossings, bridges and trestles, switches and frogs, tools, supplies, records and accounts are all taken in hand and discussed in a masterly fashion. It is full of drawings, illustrations and plans all of use to the maintenance of way engineer.

New Trade Literature

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has recently issued a 36-page illustrated booklet on wood-preserving equipment and methods. Photographs of typical plants and tables containing valuable data on the subject are included. The various processes of timber preservation and plant construction are compared.

The American Conduit Mfg. Co., Pittsburgh, Pa., have recently issued two illustrated circulars, one on Eagle Brand Lead-Zinc coated conduit for electric wiring, describing the resistance of this conduit to the action of wet slag, wet cinders, wet mortar, concrete, etc. The second circular describes their flexible Wireduct.

The American Shop Equipment Co., Chicago, Ill., have recently issued a 36-page illustrated catalogue covering shop furnaces which have been equipped with an improved type of combustion chamber. A number of the furnaces are built with a layer of insulation brick between the fire brick and the plates, to reduce fuel consumption, maintain a more uniform temperature in the furnace and maintain a cooler temperature outside for the operator. Furnaces are described for forging, welding, hammer, bulldozer, spring fitting.

The Brown Hoisting Machinery Co., Cleveland, Ohio, have recently issued a 32-page illustrated catalogue describing the various types of Brownhoist Transfer Cars and Larries. The rates of speed at which material can be moved and placed with this equipment are carefully determined and sufficient data presented to be of great value in selecting the proper type of equipment to meet given conditions.

The Bryant Electric Co., Bridgeport, Conn., have rerectly issued an illustrated catalogue comprehensively describing their wiring devices, including switches, fuses, plugs, etc.

The Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, have recently issued a 16-page illustrated booklet giving a brief survey of the variety of types of compressors and oil engines which they manufacture. Some twenty-four represented types selected from over 300 are illustrated and the classes of service for which they are most advantageous are described.

The Minwax Co., Inc., 18 E. 41st St., New York City, have recently issued a 12-page illustrated bulletin No. 3, describing floor treatments. The bulletin discussed the use of Winwax floor filler and finish for cement, composition, terrazzo, tile and marble floors and gives specifications for these and other wood floors as well as illustrating a number of typical installations.

The Newport Culvert Co., Newport, Ky., have issued a 16-page illustrated folder on "Genuine Open Hearth Iron" (Newport iron) Culverts describing the advantages of pure iron in resisting rust, and their line of corrugated pipe for culverts.

The P. & M. Co., Chicago, Ill., have recently issued an illustrated booklet on the construction and installation of their bond wire protectors for use in connection with the different types of rail joints.

The Trussed Concrete Steel Co., Youngstown, Ohio, has recently issued a 32-page illustrated book describing portable steel buildings for railroad and contractors' use. The book shows the forms of construction and various buildings in service.

The Vanadium-Alloys Steel Co., of Pittsburgh, Pa., have recently issued a 4-page illustrated reprint of an article by Roy C. McKenna, president of that company, on "Mining Tungsten Ores in Colorado." The article deals with changed conditions in the sources of supply of this important alloy owing to imports being cut off from the belligerent countries of Europe.

Westinghouse, Church, Kerr & Co., 37 Wall street, New York city, have recently issued a very attractive folder, dealing with the advantages of having reinforced concrete work designed and constructed by the same organization. Three typical examples of Westinghouse Church Kerr work are illustrated.

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., have issued a 16-page illustrated reprint of a paper presented at a meeting of the Railway Club of Pittsburgh, by E. M. Herr, president of that company. The paper deals with electric power development, through successive sizes of generating units with relation to industrial and railway electrification projects.

C-A-Wood Preserver Co., Inc., St. Louis, Mo., have recently issued a 40-page illustrated catalogue on wood preservation. The book deals with the comparative advantages of surface treatment and impregnation for wood preservation with respect to ties, sills, platforms, wood blocks and wood floors, as well as structural timbers. Methods of using the C-A-Wood Preserver and typical projects where it has been used successfully.

Supply Trade Notes

National Railway Appliances Association

Arrangements for the forthcoming exhibition of the National Railway Appliances Association in Chicago, March 20-23, inclusive, in connection with the meeting of the American Railway Engineering Association; Railway Signal Association, and the Association of Railway Telegraph Superintendents, are nearing completion.

A recent report from C. W. Kelley, secretary and treasurer, states that all of the space in the coliseum and annex have been sold with the exception of a very few small spaces.

Appended is a list of the members of the National Railway Appliances Association for this year and the representative character of the companies listed insure an interesting and instructive exhibition.

Acme Supply Co., Chicago, Ill.
Adams & Westlake Co., The, Chicago, Ill.
Adams Motor & Manufacturing Co., Chicago, Ill.
Ajax Rail Anchor Co., Chicago, Ill.
Allith-Prouty Co., Danville, Ill.
American Guard Rail Fastener Co., Philadelphia, Pa.
American Hoist & Derrick So., St. Paul, Minn.
American Kron Scale Co., New York, N. Y.
American Steel & Wire Co., Chicago, Ill.
American Valve & Meter Co., Cincinnati, Ohio.
American Vulcanized Fibre Co., Wilmington, Del.
Anchor Company, Chicago, Ill.
Armco Iron Culvert Manufacturers, Middletown, O.
Asphalt Ready Roofing Co., New York, N. Y.
Associated M'n'f'rs of Malleable Iron, Cleveland, O.
Ayer & Lord Tie Co., Inc., Chicago, Ill.
Ballow Safety Rail Joint Co., Roanoke, Va.
Barrett Manufacturing Co., New York, N. Y.
Bausch & Lomb Optical Co., Chicago, Ill.
Boss Nut Company, Chicago, Ill.
Brach Supply Co., L. S., Newark, N. J.
Bryant Zinc Co., Chicago, Ill.
Buda Co., The, Chicago, Ill.
Carnegie Steel Co., Pittsburgh, Pa.
Chicago Bridge & Iron Works, Chicago, Ill.
Chicago Flag & Decorating Co., The, Chicago, Ill.
Chicago Malleable Castings Co., Chicago, Ill.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chicago Railway Signal & Supply Co., Chicago, Ill.
Cleveland Frog & Crossing Co., Cleveland, Ohio.
Clyde Iron Works, Chicago, Ill.
Commercial Acetylene Ry. Lt. & Sig. Co., N. Y. City.
Concrete Mixing & Placing Co., Chicago, Ill.
Creepcheck Co., The, Inc., New York, N. Y.
Crerar-Adams & Co., Chicago, Ill.
Cornell Wood Products Co., Chicago, Ill.
Daniels Safety Device Co., Chicago, Ill.
D. & A. Post Mold Co., Three Rivers, Mich.
Detroit Graphite Co., Detroit, Mich.
Dickinson, Paul, Inc., Chicago, Ill.
Dillworth-Porter & Co., Ltd., Pittsburgh, Pa.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Duff Manufacturing Co., The, Pittsburgh, Pa.
Edison, Thos. A., Inc., Bloomfield, N. J.
Edison Storage Battery Co., Orange, N. J.
Electric Storage Battery Co., The, Philadelphia, Pa.
Electric Railway Improvement Co., Cleveland, Ohio.
Empire Railway Appliance Corp., New York.
Eymon Continuous Crossing Co., Marion, Ohio.
Fairbanks, Morse & Co., Chicago, Ill.
Fairmont Gas Eng. & Ry. M. C. Co., Fairmont, Minn.
Fargo Manufacturing Co., Inc., New York, N. Y.
Federal Signal Co., Albany, N. Y.
Fibre Conduit Co., The, Chicago, Ill.
Frictionless Rail, The, Boston, Mass.
Galena Signal Oil Co., Franklin, Pa.
General Electric Co., Schenectady, N. Y.
General Railway Signal Co., Rochester, N. Y.
Gurley, W. & L. E., Troy, N. Y.
Hall Switch & Signal Co., New York, N. Y.
Hatfield Rail Joint Manufacturing Co., Macon, Ga.
Hayes Track Appliance Co., Richmond, Ind.
Hazard Manufacturing Co., Wilkes-Barre, Pa.
Hoeschen Manufacturing Co., Omaha, Neb.
Hubbard & Co., Pittsburgh, Pa.
Indianapolis Switch & Frog Co., The, Springfield, O.
Ingersoll-Rand Co., New York, N. Y.
International Steel Tie Co., The, Cleveland, Ohio.
Johns-Manville Co., H. W., New York, N. Y.
Jordan Co., O. F., The, Chicago, Ill.
Joyce-Cridland Co., The, Dayton, Ohio.
Julian-Beggs Signal Co., Terre Haute, Ind.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
Kellogg Switchboard & Supply Co., Chicago, Ill.
Kelly-Derby Company, Chicago, Ill.
Keppler Glass Constructions, Inc., New York, N. Y.
Kerite Insulated Wire & Cable Co., The, N. Y. City.
Keystone Grinder & Mfg. Co., Pittsburgh, Pa.
Kilbourne & Jacobs Manufacturing Co., Columbus, O.
Lackawanna Steel Co., Lackawanna, N. Y.
Lansing Company, Lansing, Mich.
Lehon Co., The, Chicago, Ill.
Lidgerwood Manufacturing Co., New York, N. Y.
Louisiana Red Cypress Co., New Orleans, La.
Lumber Manufacturers Agency, Centralia, Wash.
Lundie, John, New York, N. Y.
Lufkin Rule Co., Saginaw, Mich.
M. W. Supply Co., Philadelphia, Pa.
MacRae's Blue Book Co., Chicago, Ill.
Madden Co., The, Chicago, Ill.
Massey Co., C. F., Chicago, Ill.
Miller Train Control Corporation, Danville, Ill.
Morden Frog & Crossing Works, Chicago, Ill.
Mudge & Co., Chicago, Ill.
National Carbon Co., Cleveland, Ohio.
National Concrete Machinery Co., Madison, Wis.
National Indicator Co., Long Island City, N. Y.
National Lead Co., New York, N. Y.
National Lock Washer Co., Newark, N. J.
National Malleable Castings Co., Cleveland, Ohio.
National Standard Co., Niles, Mich.
Nichols, Geo. P. & Bro., Chicago, Ill.
Northwestern Motor Co., Eau Claire, Wis.
Ogle Construction Co., Chicago, Ill.
Okonite Co., The, New York, N. Y.
O'Malley Beare Valve Co., Chicago, Ill.
Otley Paint Manufacturing Co., Chicago, Ill.
P. & M. Company, Chicago, Ill.

Patterson Co., W. W., Pittsburgh, Pa.
Pennsylvania Steel Co., Philadelphia, Pa.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Pocket List of Railroad Officials, New York, N. Y.
Positive Rail Anchor Co., Louisville, Ky.
Protective Signal Mfg. Co., The, Denver, Colo.
Pyrene Manufacturing Co., New York, N. Y.
Q. & C. Co., The, New York, N. Y.
Rail Joint Co., The, New York, N. Y.
Railroad Supply Co., The, Chicago, Ill.
Railroad Water & Coal Handling Co., Inc., Chicago.
Railway Periodicals Co., Inc., New York, N. Y.
Railway Review, Chicago, Ill.
Ramapo Iron Works, Hillburn, N. Y.
Reading Specialties Co., Reading, Pa.
Roadmasters & M. of W. Association, Sterling, Ill.
Roberts & Schaefer Co., Chicago, Ill.
Safety Rail Joint Co., Not Inc., Centralia, Ill.
Sanitary Bunk Co., Indianapolis, Ind.
Sellers Manufacturing Co., Chicago, Ill.
Signal Accessories Co., New York, N. Y.
Simmen Automatic Railway Signal Co., Buffalo, N. Y.
Simmons-Boardman Pub. Co., New York and Chicago.
Snow, T. W., Construction Co., Chicago, Ill.
Standard Asphalt & Rubber Co., Chicago, Ill.
Standard Oil Co., Chicago, Ill.
Standard Underground Cable Co., Pittsburgh, Pa.
Staple Post Mold Co., Westerville, Ohio.
Southern Pine Association, New Orleans, La.
Templeton Kenley & Co., Ltd., Chicago, Ill.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Track Specialties Co., New York, N. Y.
Tyler Underground Heating System, Pittsburgh, Pa.
Union Switch & Signal Co., Swissvale, Pa.
U. S. Wind Engine & Pump Co., Batavia, Ill.
Verona Tool Works, Pittsburgh, Pa.
Walker, Wm. T., Rail Bender Co., Chicago, Ill.
Wayne Oil Tank & Pump Co., Fort Wayne, Ind.
Western Electric Co., New York, N. Y.
Wharton, Wm., Jr., & Co., Inc., Philadelphia, Pa.
Whall Co., C. H., Boston, Mass.

William Edward Ballentine, general railway sales manager of the Willard Storage Battery Co., Cleveland, Ohio, died January 11, after an illness of four days. Mr. Ballentine was first associated with the Fort Scott & Memphis R. R., then with the Pullman Co., and later was head of the electrical department of the Rock Island. In 1909 he was appointed manager of the western territory of the Willard Storage Battery Co., and in 1913 was appointed general railway sales manager of that company. The success of the Willard Storage Battery Co. in the train lighting field is greatly due to his efforts.

The Bailey Meter Co., 141 Milk street, Boston, Mass., has recently been incorporated to manufacture and sell the complete line of recording meters and instruments, for power plant use, that has been developed during the last six years in the mechanical engineering department of the Fuel Testing Co., of Boston. E. G. Bailey expects to devote his energies to the new company while W. B. Calkins, who has been associated with him in the Fuel Testing Co., will continue in the work of that company. The Bailey meters are designed to accurately record the measurements of steam, water, air and gases under all conditions of pressure, temperature and capacity.

C. N. Beckner, recently appointed superintendent of construction for the Federal Signal Co. with headquarters in Chicago, entered signal work in 1902 as helper in a signal construction gang on the Norfolk & Western. In 1905 he was appointed signal foreman on the Santa Fe and in 1906 returned to the Norfolk & Western as signal supervisor on the Norfolk division. In 1910 he was appointed signal foreman of the Louisville and Nashville at Louisville, and in 1912 was made signal supervisor of the Louisville, Cincinnati & Lexington division, the Kentucky division and the Louisville Terminal. In 1914 he was appointed assistant signal engineer, where he remained until his recent resignation to accept his new position.

E. H. Bell has recently been elected president of the Railroad Supply Co., of Chicago, succeeding the late Henry S. Hawley. Mr. Bell has been vice-president of that company for some years.

The Chicago Railway Signal & Supply Co., Chicago, have recently announced the appointment of G. O. Bates as their southern representative, with headquarters at Chattanooga, Tenn.

William Andrew Conner, vice-president of the Standard Underground Cable Co., Pittsburgh, Pa., died recently in his office at Perth Amboy, N. J. In 1885 he took charge of the first plant the company built, at Pittsburgh, and from that time has been the manufacturing head of the concern.

The Duntley Product Sales Co., 810 Fisher Bldg., Chicago, Ill., has organized a railway department under the management of W. F. Caspert, formerly connected with the Monarch Steel Castings Co., of Detroit. The W. O. Duntley interests are represented by C. A. Duntley, who will be actively connected with the management of the new department.

The Economy Devices Corporation has recently announced the opening of a Chicago office in the McCormick building under the management of Joseph Sinkler.

The Kay & Ess Co. have announced the appointment of H. N. Turner, formerly eastern representative, as sales manager, with headquarters at Dayton, Ohio.

DeWitt V. Moore, recently division engineer, Central District, division of valuation, Interstate Commerce Commission, Chicago, has resigned and will take up a consulting practice in Chicago. Mr. Moore's experience includes engineering work on the Pennsylvania and a consulting practice at Indianapolis covering twenty years. He will specialize in valuation matters, particularly with the smaller railroads.

The Q. & C. Co., of New York city, have announced the acquisition of the National Railway Materials Co., and will in the future conduct the business of that company in the name of the Q. & C. Co.

The J. C. Russell Shovel Co., Pittsburgh, Pa., announce that they have made an arrangement with R. L. Mason, 1501 Oliver Bldg., Pittsburgh, Pa., to act as special representative in the railway field. Mr. Mason will have charge of railroad sales on track shovels and locomotive scoops and his broad experience in the last fourteen years especially qualifies him to be of service.

A. E. Schafer, who has for the past two years been vice-president and general sales manager of the Flint Varnish Works at Flint, Mich., has severed his relations with that company.

The Western Electric Co., Inc., of New York, has recently been formed and has taken over the assets of the Western Electric Co. of Illinois No changes in the personnel of the organization or in the policy operations and management of the company will be made.

New Methods and Appliances

Cyclodial Wier for Water Meter

The Kennicott Co., Chicago, Ill., have recently placed on the market a water meter embodying a wier with a cycloidal notch. The thought of a wier calls to mind the wiers of "V" notches and rectangular notches now in general use, and all the experience that has been secured in their operation lies back of the design of the new cycloidal notch.

Water flowing from a round hole in the bottom of the container, or wier, passes out at a rate varying in proportion to the square root of the head. The rectangular notch in the side of the wier permits the water to flow at a rate proportional to the 3/2 power of the head. The "V" notch changes this ratio to the 5/2 power of the head.

For a constant head, these ratios would any of them be sufficiently convenient for use, for once the rate of flow had been established, the mathematician could devote his time to other duties. Or, were the head to vary, and only an occasional reading be desired these ratios of rate of flow to head can be used.

It is when a record is to be kept of the water flow that these fractional exponents in the proportion complicate matters. A continuous recording device capable of recording the square root of the cube of the continuously varying reading of a rectangular notch wier is not a simple mechanism, nor is a similar device for recording the square root of the fifth power.

Fig. 1

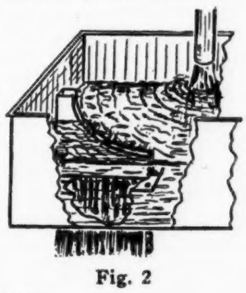


Fig. 2

Cycloidal Notch Wiers.

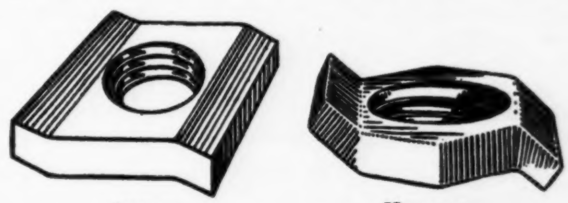
With these facts in mind, the Kennicott Co. began experimenting to find what shape of notch would permit the water to flow at a rate proportional to the head, with no intermediate computations. Starting with a rectangular slot in the bottom of the wier, experiments were made to determine how long the slot would need to be at each height for the water to flow at a rate proportional to the height or head. These lengths of slots, when plotted into a curve, formed the basis for the construction of a wier box with a curved end and a rectangular slot, shown in the sketch Fig. 1. Exhaustive tests confirmed the results of the experiment.

After the perfecting of this form of wier a mathematical investigation of the curve demonstrated it to be a right cycloid, that is, a curve generated by a point on the circumference of a circle rolling on a straight line in the same plane with the circle.

Having developed this form of wier and thoroughly tested its dependability the Kennicott Co. has incorporated it in its new cycloid wier meter, used in connection with that company's water softening and storage apparatus, the form of notch used being indicated in sketch Fig. 2. This device makes possible much more accurate measurement of water by simpler means than have hitherto been employed. Though an astonishingly rational development and one perfectly reducible by mathematical computation, no previous investigators or experimenters appear to have attempted this result—at any rate, basic patents covering the principle have been allowed the inventors by the United States patent office.

New Nut Lock and Bolt for Hollow Work

The Columbia Nut and Bolt Co., Inc., Bridgeport, Conn., have just placed on the market the Columbia Jib Nut Lock, a three-thread lock made either square or hexagon, as illustrated, which has several advantages. The threads are cut straight through the nut which can, therefore, be applied up to the holding nut with fingers and a wrench is only required to set it tight.

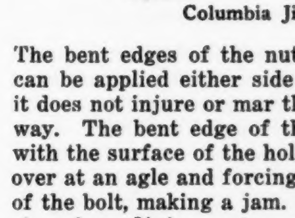


Square Hexagon

Columbia Jib Nut Locks

The bent edges of the nut being on opposite sides, it can be applied either side up, and owing to its shape it does not injure or mar the threads of the bolt in any way. The bent edge of the jib nut comes in contact with the surface of the holding nut, tipping the jib nut over at an agle and forcing its threads into the threads of the bolt, making a jam. These bolts are made in all sizes from ⅜ in. up to and including 2 ins. and both square and hexagon threads.

The Kling bolt has been designed in such a way that the head will pass through a hole of the same diameter as the stem of the bolt and will give a firm anchorage for the head on the opposite side, making it available for all hollow construction work. The bolt is split in order that the head may be passed through a hole the size of the bolt stem. This splitting does not reduce the area of the metal nor affect the tensile strength of the bolt. The area of the metal at the head is greater than the area of metal where the thread is cut.



Kling Bolt

Personal Items for Railroad Men

H. E. Astley, recently appointed division engineer of the New York, New Haven & Hartford at Waterbury, Conn., succeeding Paul Sterling, has been serving in that capacity at Hartford, Conn.

Claude L. Van Auken, recently appointed assistant engineer on the valuation of the Chicago Terminals for the Chicago, Rock Island & Pacific Railway, was formerly in the valuation department of the Chicago, Milwaukee & St. Paul Railway.

F. H. Bagley, recently appointed assistant signal engineer of the Louisville & Nashville, entered the employ of the Union Switch & Signal Co. in 1907 and after over three years of experience in all lines of work of their engineering department, he was appointed in 1910 as special assistant to the supervisor of signals on the New York division of the Pennsylvania R. R. Here for a year he conducted a school for signal maintainers on that division. Returning to the Union Switch & Signal Co., Mr. Bagley spent the next year in development work on alternating current signal, and in 1911 was a ppointed signal inspector on the Louisville & Nashville. In 1912 he was appointed signal inspector on the Louisville & Nashville and later supervisor of signals on the Cincinnati division, Kentucky division and Louisiana Terminals for that road. In 1914 he was appointed by the Interstate Commerce Commission as senior signal engineer in the division of valuation with headquarters at Chattanooga, Tenn., where he remained until his recent appointment.

C. N. Becker, recently appointed superintendent of construction for the Federal Signal Co. with headquarters at Chicago, has recentiy resigned as assistant signal engineer of the Louisville & Nashville.

F. T. Beckett has recently been appointed engineer of maintenance of way of the second district of the Chicago, Rock Island & Pacific at El Reno, Okla. The third district has been abolished.

G. W. Belew, recently appointed supervisor on the Louisburg Division of the Louisville & Nashville, succeeding W. C. Mahoney, resigned to accept a position with the N. C. & St. L., entering the service of the L. & N. as a track man in 1907 and later that year was made apprentice foreman. In 1908 he was made storekeeper of the track supply department at Columbia, Tenn., and in 1911 was appointed section foreman, which position he held until his recent appointment.

R. W. E. Bowler, recently appointed supervisor at South Fork, Pa., on the Pittsburgh division of the Pennsylvania R. R., entered the service of that road in 1905 as rodman and in 1908 was appointed transitman at Altoona. In 1909 he was made assistant supervisor on the Media division and after being transferred to Columbia, Pa., in 1910 and to Harrisburg, Pa., in 1912, nas now been promoted to supervisor at South Fork, Pa.

J. S. Brown, recently appointed assistant to the engineer of maintenance of way with office duties on the New York, New Haven & Hartford, at New Haven, Conn., has been serving as assistant engineer.

George W. Caye, recently appointed general purchasing agent of the Grand Trunk Ry. system at Montreal, succeeds J. H. Guess, resigned.

Frank D. Cooner, recently appointed transitman in the office of the engineer of maintenance of way, entered the service of that road in 1910 as rodman and was transferred to different parts of the system before his recent promotion.

Albert Darrow has recently been appointed signal supervisor on the Buffalo, Rochester & Pittsburgh, with offices at Salamanca, N. Y.

K. B. Duncan, recently appointed to the newly-created office of valuation engineer of the Atchison, Topeka & Santa Fe, has been until his recent appointment acting engineer on the Gulf, Colorado & Santa Fe.

F. T. Fisk, recently appointed assistant supervisor on the middle division of the Pennsylvania R. R., entered the service of that road in 1910 as rodman on the Buffalo division. In 1915 he was appointed transitman in the office of the engineer of maintenance of way at Philadelphia, where he remained until his recent promotion.

S. F. Gates, recently appointed assistant supervisor at Huntington, Pa., on the middle division of the Pennsylvania R. R., was transferred from a similar position at Jamesburg, N. J.

J. V. Givney, recently appointed assistant supervisor in the office of the valuation engineer of the Pennsylvania R. R. at Philadelphia, entered the service of that company in 1910 as rodman in the construction department. In 1915 he was appointed transitman in the office of engineer of maintenance of way, where he remained until his recent promotion.

F. B. Jamieson, recently appointed transitman in the office of the engineer of maintenance of way, entered the service of the Pennsylvania R. R. in 1909 as chairman of the Pittsburgh division. In 1910 he was appointed rodman on the same division, where he remained until his recent promotion.

Zeno N. Kent, recently appointed assistant supervisor at Millville, N. J., for the West Jersey & Seashore and was appointed transitman in the office of the engi- R. R., entered the service of the Pennslyvania in 1910 neer of maintenance of way in 1915, where he remained until his recent promotion.

W. G. Massenburg, recently appointed acting engineer of the Gulf, Colorado & Santa Fe, succeeding K. B. Duncan, has been serving as division engineer at Beaumont, Tex.

J. E. McIntyre has recently been appointed supervisor on the middle division of the Pennsylvania R. R. at Mifflin, Pa., and was transferred from South Fork, Pa.

Charles W. Newell, recently appointed assistant supervisor at Jamesburg, N. J., on the Trenton division of the Pennsylvania R. R., was transferred from similar work in the office of the valuation engineer.

W. H. Park, recently appointed roadmaster on the Missouri Pacific at Conway Springs, Ark., served as roadmaster on that road from 1910 to 1912, at which time there was a redistribution of territory, and Mr. Park was appointed division roadmaster on the M. K. & T. Ry. at Atoka, Okla. Returning in 1913 to the Missouri Pacific, he has served as extra gang foreman until the announcement of his recent appointment.

C. D. Perkins, recently appointed assistant to the engineer of maintenance of way with field duties, of the New York, New Haven & Hartford, at New Haven, Conn., has been serving as division engineer at Harlem River, N. Y.

W. H. Petersen, engineer maintenance of way of the First District of the Chicago, Rock Island & Pacific at Des Moines, Ia., has recently has his jurisdiction increased to include the Nebraska and Colorado divisions of that road.

L. St. Claire Pie, recently appointed assistant supervisor on the Philadelphia division of the Pennsylvania R. R., was transferred from a similar position on the West Jersey & Seashore R. R. at Woodbury, N. J.

J. S. Ruff, recently appointed division engineer of the Central New England Ry. at Poughkeepsie, N. Y., succeeding G. F. Yardley, has been serving as supervisor at South Braintree, Mass.

Edward Sheffield, recently appointed acting supervisor of signals of the Houston & Texas Central, through the leave of absence of Mr. L. H. Feldlake, has been serving as assistant signal supervisor.

A. R. Smiley, Jr., recently appointed transitman in the office of the engineer of maintenance of way of the Pennsylvania R. R., entered the service of that road in 1910 as rodman on the Trenton division.

Earle C. Smith, recently appointed acting supervisor at Titusville, Pa., on the Buffalo division of the Pennsylvania R. R., entered the service of that road in 1905 as rodman and in 1909 was made transitman. In 1910 he was made assistant supervisor in Philadelphia and has been transferred in the capacity of assistant supervisor to Haddonfield, N. J., Blairsville, Pa., Huntington, Pa., successively.

Paul Sterling, recently appointed division engineer of the New York division of the New York, New Haven & Hartford at Harlem River, N. Y., succeeding C. D. Perkins, has been transferred from division engineer at Waterbury, Conn.

A. M. Williams, recently appointed supervisor in the office of the division engineer of the Buffalo division of the Pennsylvania R. R., was transferred from Titusville.

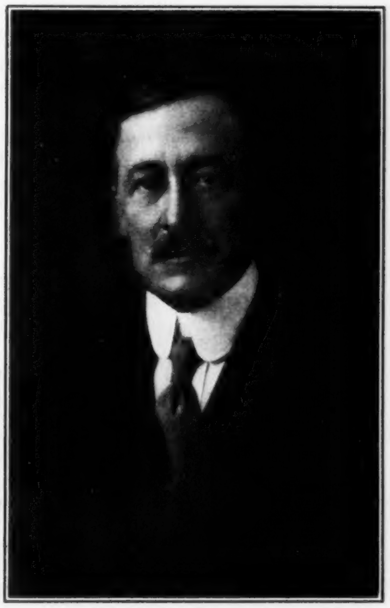
G. F. Yardley, recently appointed division engineer of the New York, New Haven & Hartford at Hartford, Conn., succeeding H. E. Astley, has been serving as division engineer of the Central New England Ry.

Obituary

William Claflin Andrews, advertising manager of the Edison Storage Battery Co., Orange, N. J., died recently in New York city. Mr. Andrews was first employed as sales engineer of the Stanley Instrument Co. of Great Barrington, Mass., and was later connected with the General Electric Co. in Schenectady, N. Y., and Harrison, N. J. Subsequently he was for two years secretary of the Rae Company, New York city, and in 1913 became advertising manager of the Edison Storage Battery Co., holding that position until his death.

Frederick Hebert Eaton died on January 27. By it the industrial world has lost one of its foremost captains. He was born in Berwick, Pa., April 15, 1863, and was descended from early Colonial stock.

Mr. Eaton had been for many years a commanding figure in the car manufacturing industry and had been engaged therein practically all his life. He obtained his early experience as chief clerk in the office of the Berwick Rolling Mill Company, then a subsidiary of the old Jackson & Woodin Car Manufacturing Company. From 1892 to 1899 he was successively secretary, vice-president and president of the Jackson & Woodin Company at Berwick. In 1899 he was an important factor



Frederick Hebert Eaton

in the formation of the American Car and Foundry Company, a consolidation of many car building companies in the United States, and which is one of the largest industrial organizations in the country today. Mr. Eaton was president and a member of the executive committee of the American Car and Foundry Company from 1901 to the time of his death. In 1906 Mr. Eaton was presidential elector on the McKinley-Hobart ticket for his native state of Pennsylvania.

Mr. Eaton was a director of the American Agricultural Chemical Company, American Beet Sugar Company, Columbia Trust Company, Hoyt & Woodin Manufacturing Company, National Surety Company, Seaboard National Bank and Sligo & Eastern Railroad Company; chairman of the board of directors of American Car and Foundry Export Company, and was a trustee of the Mutual Life Insurance Company of New York.

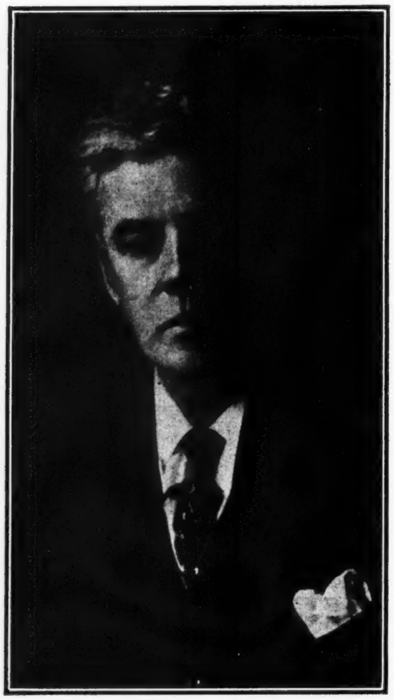
He was also a member of the New York Chamber of Commerce, the Pennsylvania Society in New York, the Society of Colonial Wars, Sons of the Revolution, Economic Club, American Geographical Society, American Society of Political and Social Science, Academy of Political Science, Peace Society of New York, Navy League of U. S., New York Genealogical and Biographical Society.

Mr. Eaton was also a member of many clubs. He is survived by his widow, Elizabeth Furman Eaton, and a daughter, Mae Eaton Crispin of Berwick. His city residence was Alwyn Court, 182 West 58th street, and his country place "Maibenfritz," Allenhurst, N. J.

John Alexander Hill, whose death occurred last week, has been a unique figure in the ranks of technical journalists, and the president and founder of the Hill Publishing Company. He was born on February 22, 1858, at Sandgate, Vermont, but early removed to Wisconsin, where he was educated. His start in life, at the age of fourteen, was in a small printing office, in which he became foreman at seventeen. His love for machinery, which was gratified in the printing office, led him to seek its further expansion in railroad life.

He took the position of fireman on the Denver & Rio Grande, and shortly afterward became a locomotive engineer. It was his practical experience on the road which enabled him later on to write those inimitable sketches entitled "Jim Skeever's Object Lessons," which faithfully portrayed the actual railroad man as he is on the real railway. Leaving active railroad life, his printing house training enabled him to found the "Daily Press" of Pueblo, Col. He edited this paper for about a year, but again turned his attention to railroad work, at which he remained until 1887. During these years he was a frequent contributor to the "American Machinist." Many of his writings appeared under the simple name of John Alexander.

In 1891 Mr. Hill formed a partnership with Angus Sinclair, another D. & R. G. locomotive engineer, and together they acquired the "Locomotive Engineer,"



John Alexander Hill

They changed its name to include the science, and made it "Locomotive Engineering." In 1885 they bought the "American Machinist," and later, when the partnership was dissolved, Mr. Hill took the "American Machinist." Under his guiding hand the property advanced in standing and in value, and its success enabled Mr. Hill to form a company which acquired not only the "American Machinist," but "Power," "The Engineering and Mining Journal," "The Engineering News" and established the "Coal Age."

In acquiring these technical publications, Mr. Hill was able to give tangible form to his enlightened ideas of the printer's life and his art. He did not see any good reason why printers should work surrounded by disorder and amid printing ink, oily rags and waste paper. He believed a printing office might be as bright and clean as any other establishment where work is done, and he made this belief a reality in his building at Tenth avenue and 36th street, New York. This building is painted white inside, and even the machinery is of the same color. It contains a tablet put up by the employes some years ago with the inscription, "Within this monument to independent truth and service in engineering journalism, the employes of the Hill Publishing Company have placed this tablet, as an appreciation of the man and employer, John A. Hill."

There was in this no idle flattery, for all had confidence in his justice and fair dealing. He is credited with many practical improvements in printing machinery and practice. He stood squarely behind his editors and never allowed the hope of advertising patronage to warp judgment or to bind honest opinion or stifle its expression. His wish was to die in harness and the grim reaper found him at his post.

Albert H. Scherzer, president and chief engineer of the Scherzer Rolling Lift Bridge Co., of Chicago, died recently as a result of injuries received in an elevator accident. In 1892 he engaged in the practice of law and on the death of his brother William, the inventor of the rolling lift bridge, he became president and chief engineer of the company. Mr. Scherzer designed a number of important railway bridges, both in the United States and abroad, and invented many improvements in bridge design.

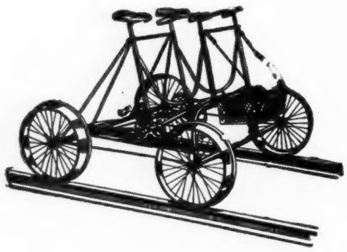
A. W. Swanitz, formerly chief engineer and manager of the Alaska Northern Ry., died recently at Alameda, Cal. Before entering the service of the Alaska Northern Mr. Swanitz was active in the construction of a number of railroads in various parts of the country.

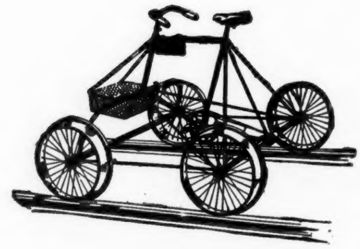
Method Used in Quenching Steel Discussed

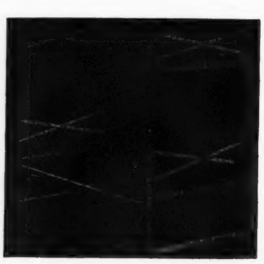
At a recent meeting of the Huddersfield Engineering Society, says a recent commerce report, Mr. Shipley N. Brayshaw lectured on "The Quenching of Steel." The lecturer discussed the properties which determined the value of any liquid as a quenching medium, and pointed out that the main items of consideration in this direction were specific gravity, specific heat, boiling point, conductivity, and fluidity, and gave some interesting information in connection with experiments which he had carried out in the hardening of tools in various ways, and by means of various quenchers.

He described the effects of stirring the quenching medium, and also the use of jets for throwing a strong stream against the articles to be cooled. He referred to the use of brine and a freezing mixture of snow and salt. He pointed out that the age of water had a great deal to do with its quenching powers, and instanced the carrying away of water in barrels from the River Don, in Sheffield, even as far as the United States for this purpose, owing to some peculiar property which it possessed.

The uses of oil, mercury, fusible oils, and fusible salts as quenching media were dealt with, and the lecturer laid down as the ideal medium for quenching, one which was from fluid at 100 degs. C., at a high boiling point of practically 800 degs. C., fairly high specific gravity, and of fairly good specific heat. This would give a glass-like hardness to the tools, but the quenching should be carried out at such a temperature that the heat left would prevent breakage.







CLASSIFIED INDEX OF ADVERTISERS

Classified Index of Advertisers—Continued

Alphabethical Index of Advertisers